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A

SYSTEM OF SURGERY.

VOL. III.

DISEASES OF THE EYE AND EAR, OF THE ORGANS
OF CIRCULATION, MUSCLES, AND BONES.

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SYSTEM OF SURGERY

THEORETICAL AND PRACTICAL

IN

TREATISES BY VARIOUS AUTHORS.

EDITED BY

T. HOLMES, M.A. CANTAB.

SURGEON AND LECTURER ON SURGERY AT ST. GEORGE'S HOSPITAL

MEMB. CORRESP. DE LA SOCIÉTÉ DE CHIRURGIE DE PARIS.

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BY J. DIXON, Esq.

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DISEASES OF THE EYE.

CHAPTER I.

OPTICAL DEFECTS.

Emmetropia (Refraction and Accommodation).—Ametropia (Myopia, Hypermetropia, Presbyopia, Astigmatism).

ASSUMING the reader to be acquainted with the general laws of optics, I may begin by saying a few words about the eye as an optical instrument; and may then briefly describe those defects in its refraction and accommodation which interfere with the perfect performance of its functions.

The terms *Emmetropia* and *Ametropia** have been invented by Donders to designate the normal and the abnormal state of the eye in respect of its refractive phenomena. An eye of perfectly normal refraction, in which parallel rays of light meet in a focus on the retina, Donders calls *emmetropic*—*Emmetropia* implying ‘sight within due measure’ (*Ἐμμετρος*, within measure, and *ὥπια* the terminal modification of *ὥψ*, sight). An eye in which parallel rays come to a focus either in front of or behind the retina, he calls *ametropic* (*ἀ* and *μετρωπία*).

Although we familiarly speak of the rays of light that come to us from distant objects as being parallel to each other, yet, strictly speaking, all luminous rays pass off from their source

* The generic term *Ametropia* is seldom employed, inasmuch as that special form of it which happens to be immediately under observation, leads one to use the terms *Myopia*, *Hypermetropia*, or *Presbyopia*. But were the word ‘*Ametropia*’ often pronounced by Englishmen, it would be constantly liable to be mistaken for ‘*Emmetropia*,’ its direct opposite, in consequence of the peculiar sound of our close *a*. On the Continent, where the *a* has uniformly its broad open sound (as in *father*), this confusion cannot occur. Our strictly English eccentricity might have been indulged, while at the same time the distinction between the two generic terms would have been made even more marked, if *Ecmetropia* had been chosen as the converse of *Emmetropia*.

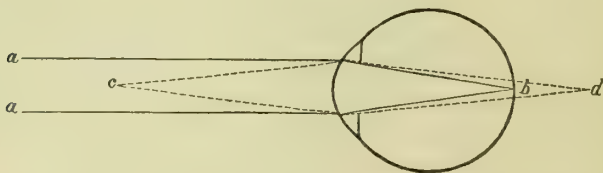
divergently. It is obvious, however, that the divergence of any rays falling on the eye must become less in proportion as their source is removed farther off; so that by the time the rays from a distant object are passing through the small aperture of the pupil, their divergence has become so trifling that, for all practical purposes, they may be regarded as parallel.

In considering the eye as an optical instrument, we have to do only with those rays of light which are admitted by the pupil—they alone being concerned in vision.

While in a perfectly formed, and normally refractive, or emmetropic eye, the rays from distant objects would naturally come to a focus upon the retina, and there form a picture which is to be recognised by the sensorium, the rays from near objects, falling on the surface of the cornea in a state of more or less divergence, would, in passing on through the refractive media of the organ, tend towards a focus behind the retina. (Fig. 140.)

To effect near vision, therefore, it becomes necessary that the media should undergo such a change as will bring divergent rays to an exact focus on the retinal surface. This change is the result of an active effort which is called *Accommodation*.

FIG. 140.



Emmetropic eye in a state of rest. Parallel rays, *a, a*, come to a focus on the retina at *b*. Rays from a near object, *c*, being divergent, tend towards a focus behind the retina, *d*. The act of accommodation, which consists in increased convexity of the lens, causes these divergent rays to converge to a focus at *b*.

Various theories have at different times been suggested to explain the mechanism of this act of adjustment or accommodation of the eye to near objects. First, it was said that by a contraction of the recti muscles the eyeball was compressed on all sides, and thereby elongated in its antero-posterior diameter, and thus the retina was actually removed backwards into such a position as enabled it to receive upon its surface the exact focus of the rays. Secondly, according to another theory, the act of accommodation consisted in an increased curvature of the cornea. This Home and Ramsden considered themselves to

have proved by conclusive experiments. Thirdly, it was maintained that the lens was moved bodily forwards.*

Three of the foregoing theories of accommodation are evidently fallacious. 1. In a case of total paralysis of the third, fourth, and sixth nerves, all the ocular muscles are inert, and yet the patient's vision of near objects remains totally unimpaired. 2. The curvature of the cornea has been carefully tested, and found not to vary during the act of accommodation. 3. No apparatus exists adequate to move the entire lens forward to an extent sufficient for the purpose of accommodation. During the performance of the delicate experiments I am about to allude to, no change in the position of the entire lens could be detected. 4. An increase in the convexity of the lens, especially of its anterior surface, is now universally accepted as the cause of the eye being accommodated to near objects.† Theoretically such a change of form will account for the attainment of the end in view; and practically it has been found, by carefully watching the alterations in the reflected images of a flame held in front of the eye, that, while the reflection from the surface of the cornea remains totally unchanged during the act of accommodation, the images reflected from the anterior and posterior faces of the lens (Purkinje's ‡ images they are termed) change both their size and relative position.

* This movement was effected, according to Porterfield, by a contraction of the ciliary processes; or, as he termed them collectively, the *ligamentum ciliare*. Porterfield, however, knew nothing of the existence of what is now called the 'ciliary muscle.' (See his *Treatise on the Eye*, &c. 1759, vol. ii. p. 4.)

† This theory was first published by Young in 1793; but along with it he brought forward the mistaken notion that the change in the shape of the lens was owing to its possessing an inherent power of contraction, due to its being wholly made up of muscular fibres and tendons. This anatomical error had been previously advanced by Pemberton, in 1719. In 1796, Young retracted the theory he had brought forward three years before, declaring it to be 'neither new nor true,' and accepted the change of curvature in the cornea as the efficient cause of accommodation. At a later period (1800), while he abandoned the opinion that the lens was muscular, he still maintained that it possessed within itself a power of changing its form, and that by increasing its convexity, it adapted the eye to near objects. (*Phil. Trans.* 1801.)

‡ The following is Purkinje's experiment, which, before the invention of the ophthalmoscope, was frequently employed as a 'catoptric test' of the presence of incipient cataract. The patient, with his pupil dilated, is placed in the dark, and a lighted taper is then held on a level with, and at a few inches from the pupil. Three images of the flame are then perceived; one, large, distinct

The ciliary muscle is now generally believed to be the active agent in changing the shape of the lens during accommodation, but the precise mode in which the process is effected is not easy to explain. The iris also seems in some way to aid the ciliary muscle, but that the iris is not the chief agent in accommodation is proved by the fact that, in cases where it is absent from birth (*Irideremia*), or where it has been removed from the eye by an accident, accommodation seems but little impaired.

The temporary loss of accommodation in persons who have severely suffered from diphtheria illustrates the dependency of the function on some form of muscular action. In such patients, long after all their acute throat-symptoms have passed away, and they are resuming their ordinary employments, a remarkable weakness in some of the small muscles of the body becomes manifest; the palatal muscles are found to be impaired in their action, and at the same time the power of reading is lost, or it can be exercised only for a few seconds. This defect of vision is not due to any impairment of the optic nerve, for a convex glass held in front of the eye at once compensates for the loss of accommodating power, and enables the patient to read clearly.

Near and far points of distinct vision.—There is a limited range within which small objects, printing-types, for instance, can be distinctly seen by a healthy, or emmetropic, eye. If they are brought nearer to the eye than a certain point, they can no longer be recognised. This is called the ‘near point of distinct vision.’ If the types be moved farther off, they can still be read until they have receded to a certain distance, when they again become indistinguishable. The space comprised between these two points is called the ‘range of accommodation.’

The *far-point* in an emmetropic eye is said to be ‘at an infinite distance.’ That is to say, rays of light from the most distant objects, the stars for instance, come to a focus upon the retina while the eye is in a state of rest. It is evident that if we use ‘infinite’ in its strictly etymological sense, no two things

and upright, is reflected from the cornea; two others, much smaller than the corneal one, appear within the pupil. Of these deeper images, one, inverted, is reflected from the hinder face of the lens; the other, upright, from its front surface. If the taper be now slowly moved from side to side, the inverted image, which is always ill-defined, quits its position between the two upright images reflected from the cornea, and from the front of the lens, and glides away in a direction opposite to that in which the taper is moved.

can be at an infinite distance from each other. The word, however, is technically applied to rays which, being inappreciably divergent, are therefore treated of as if really parallel; not only such as come to us from one of the heavenly bodies, but even from an object several yards off. As some distance must be assigned respectively limiting the bounds of finite and infinite rays, twenty feet is commonly spoken of as the distance by ophthalmic writers; appreciably divergent rays, coming to the eye from an object less than twenty feet distant being called 'finite,' and those from all objects beyond that distance 'infinite.'

Ametropia.—The chief forms of ametropia are those popularly known as 'short-sight,' and 'long-sight.' The latter, in its true meaning, will come to be considered under the term presbyopia; but there is another form, the clear discrimination of which we owe to Donders, and to which he has given the name of 'Hypermetropia.' It is a very common affection, depending on original malformation of the eyeball, and affecting therefore persons of all ages. In short-sight (*Myopia*), parallel rays such as pass to the eye from a distant object, come to a focus in front of the retina; in Hypermetropia the rays tend to a focus behind the retina.

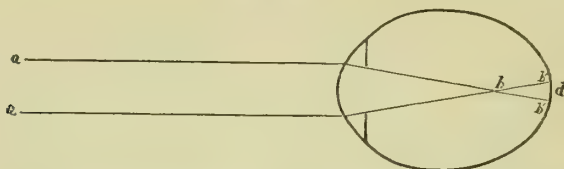
On the same principle of terminology which induced Donders to name this defect Hypermetropia—the sight being, as it were *ὑπέρμετρος*, above the measure—short sight would be called *Hypometropia* (*ὑπομετρος*, below the measure); but Donders has chosen to retain the term 'Myopia' for two reasons; first because the word is established and universally accepted, and secondly, because the similarity of sound between 'hypo' and 'hyper' would be apt to cause confusion and misunderstanding.

In *Myopia* (Fig. 141) the eye is adapted for bringing divergent rays to a focus on the retina; but parallel rays come to a focus in front of it, and then, again diverging, pass on to form upon its surface what are called 'circles of dispersion,' and thus an ill-defined image of a distant object is produced.

A concave glass, of a curvature proportioned to the degree of myopia, held in front of the eye, causes parallel rays to diverge before entering the pupil, and they are then reunited, and brought to a focus exactly upon the retinal surface (*d*). The cause of myopia consists either in the media of the eye, especially the lens, being too highly refractive, or in the eyeball itself

being too long from before to behind. This elongated, ovoid form of the eye is best seen when the patient forcibly adducts it.*

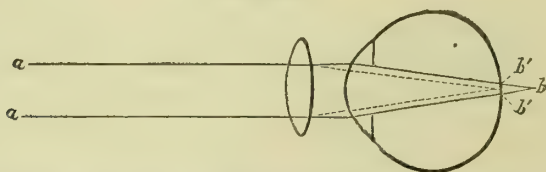
FIG. 141.



Myopic eye; too long in its antero-posterior diameter. Parallel rays, before reaching the retina, come to a focus at b ; then, crossing, they form on the retina circles of dispersion at b', b'' .

In *Hypermetropia* (Fig. 142) the parallel or quasi-parallel rays from distant objects tend towards a focus behind the retina, while the divergent rays from near objects cannot be brought to a focus on the retina until, by artificial means, they have been made to converge. A hypermetropic patient, therefore, sees neither distant nor near things distinctly. Hypermetropia is caused either by the eyeball being too short from before to

FIG. 142.



Hypermetropic eye; too short in its antero-posterior diameter. Parallel rays, tending towards a focus at b , form on the retina circles of dispersion at b', b'' . Divergent rays would tend towards a focus still more distant than b .

behind (Fig. 142), or by the refraction of its media being too low; or both these conditions may be combined. Convex glasses, of suitable focal length, make both distant and near objects distinct, by causing parallel and divergent rays to converge, and thus bringing them to a focus on the retinal surface.

Presbyopia ($\pi\rho\acute{\epsilon}\sigma\beta\upsilon\varsigma$, aged). Persons who originally have had excellent sight, both for distant and near objects (*Emme-*

* Porterfield says: 'By myopes I understand such as have the cornea and crystalline, or either of them, too convex, or that have the distance betwixt the retina and crystalline too great.'—*A Treatise on the Eye*, &c. Edinb. 1759, ii. p. 36.

tropia), as they advance in life find that, while their distant sight is as acute as ever, near objects become more and more indistinct. Type is held farther and farther from the eyes, as the 'near point' recedes. The accomodating power has become impaired, partly by the lens acquiring greater firmness, and therefore being less able to yield to that force which ought to render it more convex when near objects are looked at; and partly from that force itself becoming weaker. A convex glass, of such a curve as will bring back the receded 'near point' to its normal position, at once renders near objects distinct.

Although a presbyopic and a hypermetropic person may both be seen using convex glasses for reading, the state of their vision is very different. The presbyopic person may have been originally emmetropic, his eyes in a state of rest bringing parallel rays to a focus on the retina, and his accommodating power, by changing the form of his lens, serving also to bring to a focus on the retina the divergent rays from near objects.

In the hypermetropic person, on the contrary, sight was always defective, both for distant and for near objects. On account of its short anterior-posterior diameter, the eye, while in a state of rest, could not receive upon the retina parallel rays; they all tended to a focus behind it, while the divergent rays from near objects could not be focussed on the retina until they had artificially been changed into convergent ones.

Presbyopia and hypermetropia, therefore, are the direct contrasts to each other. Even a myopic patient, in advanced age, will sometimes be found to a certain degree presbyopic, in consequence of the failure in accommodation which is induced by increased density in the tissue of the lens.

Astigmatism.*—In an eye otherwise perfectly formed the cornea may be unsymmetrical, so as to present different curves accordingly as its anterior surface is measured vertically, transversely, or obliquely. The rays of light, therefore, as they fall on one or other of these meridians of the eyeball, become differently refracted, and cannot all meet at one point or focus.

* *Astigmism* would be the more correct term, *στιγμή* (*στιγμῆς*), being commonly used by Greek writers to express a geometrical point, while *στίγμα* (*στιγματός*), always signifies something material, more or less visible or tangible—a puncture, mark, or spot. I took the liberty of pointing this out to the late eminent scholar Dr. Whewell, who had originally suggested the word 'Astigmatism,' and he approved of *Astigmism*, as being etymologically the better-formed word.

The researches of Donders and others show that astigmatism, at least in a slight degree, 'is by no means so uncommon as was formerly supposed. It is best detected by making the patient look at a paper on which are drawn vertical and horizontal lines of equal thickness, and noting which lines become the more clearly defined at a given distance. Young, who was himself affected with astigmatism, was the first to describe this peculiarity of vision.* He believed the cause to be in his lens, which he imagined to be placed obliquely to the axis of vision. Airy † next published an account of this condition, as affecting one of his own eyes, and he invented a glass of a peculiar form to correct the irregular refraction. Glasses of this kind are now commonly used, under the name of cylindrical or astigmatic glasses. Such a glass must be a segment of a cylinder, the axis of which is then placed before the eye vertically, transversely, or obliquely, according to the meridian of irregular refraction. For a myopic or hypermetropic patient the glass must be concavo-cylindrical or convexo-cylindrical. An instrument for determining the precise direction of the axis of a symmetry has been invented by Laurence.

I may now make a few remarks on some special points in the diagnosis and treatment of Myopia and Hypermetropia.

As I have already observed, a myopic eye is so formed as to be adapted for bringing strongly divergent rays to an exact focus on the retina; and therefore the minutest near objects are often seen with extraordinary clearness of definition, so that a 'diamond' type can be read with perfect ease at a distance of four or five inches, although at only double that distance it becomes quite illegible. As soon as the object has been removed beyond the far-point of distinct vision, the rays, after coming to a focus in front of the retina, again diverge, and form upon it the 'circles of dispersion' already alluded to. The farther the object is removed from the eye, the larger these circles become; and the patient instinctively brings the edges of his lids close together, as he finds by experience that, by thus cutting off some of the rays which would otherwise enter the pupil, the dimness caused by the circles of dispersion is diminished.

There is an endless variety in the range of accommodation

* In the year 1800; *Phil. Trans.* 1801.

† In 1825; *Trans. of the Cambridge Phil. Soc.* vol. ii. p. 257. In his second paper, 1846 (*Trans.* viii. 361), he mentions that Whewell had suggested the name 'Astigmatism' to designate the affection.

among myopic patients. Some can read the smallest type at a distance of 5 or 6 inches, others only at 2 inches from the cornea. Each case must be examined and judged of by itself, for there are many complications which may prevent our always applying the same unerring rule for deciding what form of concave glass is required to neutralise the myopia. Commonly, however, we may ascertain what degree of concavity will suit for clear vision of distant objects by noting at how many inches from the cornea a small test-type can be distinctly read, and then giving the patient for distant objects a concave glass of corresponding focal length. Thus a patient who with the naked eye can define the test-type only at 5 inches is said to be myopic $\frac{1}{5}$, and a concave glass which would neutralise a convex one of 5 inches focus, and which is distinguished as —5'', will enable him to see distant objects with accuracy.

In determining what arrangement of glasses should be made use of, the degree of myopia and the patient's general circumstances must be considered. If his sight for near objects be acute, and his amount of myopia not very great, the occasional use of a hand-glass or spectacles may be enough; but in no case should a single glass be employed. The habitual use of a glass to one eye, has in some cases a tendency to induce in the other a feebleness of vision, and a slight eversion of the eyeball. When the myopia is so considerable that type cannot be discerned unless held within 2 or 3 inches of the cornea, spectacles ought constantly to be worn.

In speaking of hypermetropia, I said (p. 6.) that, in consequence of a short antero-posterior diameter of the globe, neither parallel nor divergent rays could be brought to an exact focus on the retina. Now these are the only rays that are met with under natural conditions; or rather, as I have already observed, all luminous rays, strictly speaking, fall upon the surface of the eye with a greater or less amount of divergence. Convergence of rays is always an artificial result, caused by their transmission through a convex lens.

The unassisted hypermetropic eye, therefore, sees neither near nor distant objects distinctly; but the difficulty of seeing near and small things is so much more obvious to the patient than his inability to define distant ones, that he commonly seeks medical advice on account of difficulty in reading. To make the retinal image larger, he often brings the type near to the eye, and hence believes himself to be 'short-sighted.' But

even when held near, he can only read it for a very short time, with a constant painful effort, and a sense of straining and fatigue; and when the defect exists in a very high degree, reading is altogether impossible.

The only remedy for hypermetropia is the use of convex glasses. The cause of the defect was formerly very imperfectly understood, although its results were familiar to every ophthalmic surgeon, and constituted one of the most troublesome and unsatisfactory portions of his practice. Under the vague title 'Impaired Vision,' cases of hypermetropia were treated with an endless variety of external and internal medicines, all equally fruitless.

The focal length of the lens necessary for giving such convergence to parallel and divergent rays as may suffice to bring them to a focus on the retina affords a designation for the degree of hypermetropia.* Thus if a glass of 10 inches focus produces upon the retina an exactly defined image of the test-type, while distant objects are clearly seen with a glass of 30 inches, the patient is said to be hypermetropic $\frac{1}{10}$ and $\frac{1}{30}$.

As hypermetropia depends upon an original malformation of the eyeball, children affected with it must be provided with suitable spectacles, or they will be unable to read sufficiently for the common purposes of education. Donders insists on the necessity for spectacles being constantly worn by hypermetropic patients, so as to prevent over-exertion of the effort of accommodation; but we can hardly expect a school-boy to play in spectacles, however willingly he may resign himself to them as indispensable for study, and we must in most cases content ourselves with insisting on their being always used for reading, writing, drawing, &c. Adults who, although hypermetropic, have committed themselves to unsuitable occupations, involving continuous application to near objects—clerks, compositors, tailors, needlewomen—will usually be willing enough to wear spectacles at all times. In some cases one pair of glasses will suffice, in others more convex lenses will be needed for near objects, and less convex ones for distance.

Test-types.—It is evident that in examining a patient's sight some definite tests must be selected, and printing-types are the best and most convenient objects. As freer intercourse was established between different countries, it became more and more desirable that some uniform standard of reading-tests should



TEST TYPES :

*Corresponding in size to the 'Schrift-Scalen' of
Professor Jæger. (1860.)*

No. 1.

First, I was to prepare more land, for I had now seed enough to sow above an acre of ground. Before I did this, I had a week's work at least, to make me a spade, which, when it was done, was but a sorry one indeed, and very heavy, and required double labour to work with it. However, I went through that, and sowed my seed in two large flat pieces of

No. 3.

ground, as near my house as I could find them to my mind, and fenced them in with a good hedge, the stakes of which were all cut of that wood which I had set before,

No. 5.

and knew it would grow; so that in one year's time I knew I should have a quick or living hedge, that would want but little repair. This

No. 6.

work was not so little as to take me up less than three months, because a great part of that time was of the wet

No. 8.

season, when I could not go abroad. Within doors, that is when it rained and I could not go

No. 10.

out, I found employment on the following occasions; always observing that, all the

No. 12.

while I was at work, I diverted myself with talking to my parrot,

No. 14.

teaching him to speak.
I quickly taught him

No. 15.

to know his own
name, and at last

No. 16.

to speak it out
pretty loud 'Poll,'

No. 18.

it was the
first word

No. 19.

I ever

No. 20.

heard

be agreed upon, so as to enable ophthalmic surgeons to understand the reports of each other's cases. The sizes of printing-types, however, are not everywhere the same, and persons are usually unacquainted even with the typographical terms of their own country—*pearl*, *minion*, *brevier*, *bourgeois*, *pica*, &c.—unless they happen to have had some practical experience as authors. When, therefore, E. Jæger published in 1854 a series of printed tests, the letters of which were distinguished by numbers instead of by technical names, they were generally accepted by the profession, and referred to in reporting cases. More recently Snellen has devised a special form of type, in which the letters are all drawn on a regularly proportioned scale of thickness of stroke.* In doing this, he has acted on the following principle. If the eye be taken as a centre, and from it a circle be described of 12 inches in diameter, a well-illuminated object occupying only $\frac{1}{60}$ of a degree in this circle can be recognised. In other words, certain objects, the size of which is about $\frac{1}{600}$ of an inch, can be seen by an emmetropic eye, at a distance of 6 inches. Such objects, however, as printing-types cannot be distinctly perceived at a smaller visual angle than about five minutes of a degree. Snellen's letters, therefore, are uniformly drawn in lines the thickness of which is equal to one-fifth of the whole letter, so that, while a letter occupies five minutes of the field of vision, each line composing the letter would occupy a space of only one minute. Each size of Snellen's type is distinguished by a figure, indicating the number of feet at which the letters ought to be legible to an emmetropic eye. In a second edition of his test-types (1864) Snellen printed some tables of 'test-dots,' which may be used by persons who cannot read. These dots had been contrived by the British army authorities for determining the acuteness of vision in recruits.

No doubt the principles on which Snellen's letters are formed are more scientific than those which regulate Jæger's, and are to be preferred in cases where optical experiments are made on intelligent and educated persons. But those of limited reading powers, especially in hospital practice, are often puzzled by the

* It is only with letters of a certain size, however, that Snellen has carried this plan into effect. The larger letters are all drawn on the principle he lays down, but his letters No. 1, No. 2, and No. 3, are all printed from ordinary thick and thin metallic types. (*Test-types for the Determination of the Acuteness of Vision*, 3rd edit. 1866.)

unusual forms used by Snellen, and cannot read them fluently, even when quite able to read the ordinary type they are accustomed to in books and newspapers.

CHAPTER II.

EXAMINATION OF THE EYE.

Superficial Examination.

The Conjunctiva and Cornea.—For examining the former of these structures, when attacked with the slighter forms of ophthalmia, no special manipulations are required. The ocular portion is open to the surgeon's observation, and, to explore the lining of the lower lid, it is only necessary to depress the tarsus with the point of the finger. It is often difficult, however, to obtain a satisfactory view of the cornea in a child suffering from that irritable form of inflammation commonly known as *Scrofulous Ophthalmia*, but more correctly called *Keratitis*. The surgeon does but waste his time who attempts to coax or parley with such a patient. Light causes so much pain, that the child makes every effort to exclude it, by keeping the eyelids firmly pressed together, and even, in severe cases, thrusting his face against the pillow, or the dress of the attendant.

The surgeon should sit, and spread a folded towel across his knees. Opposite to him sits the attendant, who secures the child's hands, and lowers him backwards until his head is received between the surgeon's knees, and there firmly held. Thoroughly to expose the cornea without everting the lids requires tact, which practice alone can give. The extreme tip of the fore-finger, with a bit of rag twisted over it to prevent slipping, having been laid upon the middle of the upper tarsus, at the very edge—between the roots of the eyelashes and the globe—the lid, without any dragging of the skin, is to be steadily pushed in a direction which, in the erect position of the body, would be upwards and backwards. In this way the greater part of the cornea is at once exposed; but if the finger is allowed to drag the skin of the lid, the tarsal cartilage instantly becomes tilted over, and the swollen conjunctiva, bulging forwards, hides the eyeball from view. By a similar

manœuvre the lower lid may be depressed; but this is not necessary in examining the cornea, for that part is always rolled upwards to seek the shelter of the upper lid.

If a more prolonged examination of the eyeball be required, as in a case of *Ophthalmia neonatorum*, a spring speculum must be employed, adapted, as regards width and strength of spring, to the small size of the palpebral fissure.

To expose the conjunctiva of the upper lid, the part must be everted, as if the surgeon were in search of a foreign body; and, indeed, it is with such an object that the eversion is most frequently performed. Whenever a patient complains of having had a fragment of anything blown into the eye, and a careful scrutiny of the edges of the tarsi, the fold of the lower lid, and the surface of the globe, has failed to reveal the cause of irritation, the upper lid should be treated in the following manner:—A pen, the extreme feather end of which is cut off, so as to leave a stem just thick enough to resist bending, is laid across the upper lid, about half an inch from its free margin; then, while the finger and thumb of the other hand grasp the eyelashes growing from the middle of the lid, the pen is pressed a little downwards, at the same moment that the lid is drawn first a little forwards, and then upwards; the tarsus will suddenly tilt and fold over, so as to expose its conjunctival surface.

This manœuvre, simple as from description it seems to be, requires a good deal of *knack*. Both hands must act together, and if at the moment the turn is being given to the lid, the patient is told to look downwards, the eversion is much more readily accomplished. Minute foreign bodies, which have fixed themselves beneath the upper lid, are almost invariably found very near its tarsal margin; they should be lightly picked off with the feather or nib of the pen used for effecting the eversion. A pen is not only more convenient than a probe, but it has the advantage of appearing less formidable to a timid patient.

Lens and iris.—Great care is required in examining a patient in whom we have reason to suspect that Cataract is commencing. The first faint streaks of opacity in a lens will often escape detection, unless light be concentrated on the part by means of a convex glass of about an inch focus. I need hardly say that in all daylight examinations of the eye, the direct rays of the sun are to be avoided. The observer must also take care that light does not fall upon the cornea from more than one window;

and that reflections from mirrors and other polished surfaces do not interfere with the single ray of direct light which should fall on the part to be examined. No lens can be fully seen until the pupil has been widely dilated with atropine; but inasmuch as this dilatation alters the visual condition of the eye, all particulars as to the patient's range and distinctness of sight should be noted before the atropine is applied.

In the very earliest stages of Cataract, examination by daylight, even when the light is concentrated by a convex glass, may sometimes fail to detect alteration in the lens. Neither can this be made out with the ophthalmoscope. But if in a darkened room the rays of a flame be thrown sideways upon the lens, by means of a convex glass, and the part be then carefully scrutinised with the naked eye, highly refractive dots, like minute oil-globules—which probably they really are—will be found scattered throughout the substance of the lens, the fibres of which also are now made visible as delicate radiating lines.

The contractility of the iris is tested by placing the hand close to the eye for a second or two, and then quickly withdrawing it, so as to allow the light to fall suddenly upon the pupil, the other eye meantime being closed. The sympathy between the two eyes should next be examined, by observing how far light admitted to one eye influences the iris of the other.

This separate examination of each eye is a very important point, for cases occur in which, while one eye is sound, the other is so utterly blind as to have lost all perception of light, yet the pupil of this blind eye will contract as soon as light is admitted to the sound one. An extensive adhesion between the edge of the pupil and the capsule of the lens (*Synechia posterior*) would at once attract notice; but if any slight deviation from the healthy round form of the pupil exists, its margin must be carefully examined, to see if any very small adhesion be the cause of such irregularity. A very slight synechia often affords a valuable hint towards diagnosis, as proving that iritis must at some period or other have attacked the eye. Whenever the surgeon is in doubt as to the existence of adhesions, the application of atropine will determine the question.

It should ever be borne in mind that a dilated and inactive pupil by no means necessarily implies that the retina is diseased; nor an active pupil that the retina is sound. If one pupil be large and immovable, and the sight of that eye dim, the patient should be made to look at type through a large pin-hole in a card

held close to the cornea. The object of this will be explained under the head 'Mydriasis.'

We must never be satisfied with a patient's vaguely telling us that he can or cannot read; we must have a precise and definite standard, such as is afforded by his reading to us aloud from type of several sizes. In hospital practice, those who have not learned their letters—who, as they express it, are 'no scholars'—may be told to count small dots, point out a single and a double line, or select an asterisk from other typographical marks. This subject has been more fully treated under the head of 'Optical Defects.'

The simple modes of examination hitherto mentioned have at all times been at the surgeon's command; I come now to consider the use of an apparatus—the *Ophthalmoscope*—the invention of which has enabled us to explore those deeply-seated structures previously altogether beyond the range of observation.*

OPHTHALMOSCOPIC EXAMINATION.

It is little more than twenty years since Cumming† first demonstrated that, by a certain arrangement of light, the fundus of the healthy human eye could be made visible, so far at least as to allow of its colour being seen. Although he never obtained a view of the optic nerve or vessels of the retina, his investigations prepared the way for the discovery of the ophthalmoscope, by proving that the fundus of the living eye was not really a dark-coloured surface; but that under certain conditions it reflected the rays of light falling upon it, so as to present a brilliant surface to the eye of the observer. An indistinct reddish gleam from the retina, or a white reflection from the optic nerve, had been sometimes accidentally seen by those engaged in the study of eye-diseases; but they had regarded these glimpses of the fundus of the eye as exceptional, and as indicating something morbid in the deep tissues. Thus, in certain cases of impaired sight, with dilatation of the pupil, Beer had

* In the first edition of the present Essay there was no special section on the Examination of the Eye. In now adding a preliminary chapter on the subject, I have here and there made use of a paragraph from my little volume on *Eye Diseases*. When I have had to repeat former statements, I have not thought it necessary to vary the wording merely for the sake of giving an air of novelty to some commonplace directions.

† *Medico-Chirurgical Transactions*, 1846.

observed a peculiar luminous appearance, which he assumed to be the result of some morbid change in the retina; and he accordingly made use of the term 'cat's-eye amaurosis' to designate the disease which he supposed to give rise to this luminous appearance. Other observers had attributed it to a deficiency of pigment, still assuming that, in a state of health, the fundus of the eye must necessarily appear black.

The first ophthalmoscope was invented by Helmholtz, and described by him in a tract published in 1851.* He began by showing in how simple a manner, by using a slip of glass, the surface of the retina might be made visible; and then constructed an apparatus of several superimposed glass plates, with which he obtained a more perfect view of it. These first examinations were made without any artificial dilatation of the pupil, so that only a limited extent of the retina could be seen. He was able, however, to distinguish the optic nerve, and the vessels emerging from it.

In 1852 Ruete† invented an ophthalmoscope on a different principle from that of Helmholtz, light being thrown into the patient's eye by means of a concave mirror, through a hole in the centre of which the observer looked directly upon the illuminated retina. The practical objection to Ruete's instrument consisted in its being fixed to a stand, and therefore ill adapted to observe an organ so frequently in motion as the eye. Coccius‡ avoided this inconvenience by constructing a small perforated mirror, to be held in the hand; and this instrument was still further modified by Anagnostakis,§ whose ophthalmoscope, from its extreme simplicity, appears to me one of the most useful that has yet been invented, and quite the best for the student to begin with. It consists of a circular glass mirror about an inch and three-quarters in diameter, slightly concave, and perforated in the centre with a round hole, the tenth of an inch wide. The mirror is set in a metal frame, to which a handle is fixed. Liebreich's instrument is made, not of glass but of polished metal, with a focus of from four to six inches. One of the advantages of the metallic mirror is that the edge of

* *Beschreibung eines Augenspiegels zur Untersuchung der Netzhaut im lebenden Auge*, Berlin.

† *Der Augenspiegel und das Optometer*, Göttingen.

‡ *Ueber die Anwendung des Augenspiegels*, Leipzig, 1853.

§ *Essai sur l'Exploration de la Rétine et des Milieux de l'Œil sur le Vivant*, Paris, 1854.

the aperture can be made quite thin, whereas the glass mirror must be backed by a plate of metal, and by drilling through this, and through the thickness of the glass, the aperture really becomes a short tube. Any reflection from the wall of this tubular aperture must be prevented, by carefully covering it with a dead black coating. At the back of Liebreich's instrument there is a little hinged clip for holding a convex or concave glass against the sight-hole. The concave glass is necessary in making an examination by the 'direct' method, if the patient or the observer be myopic.

There are various forms of the ophthalmoscope which, in the hands of practised observers, will afford a good view of the fundus of the eye, but it is well for the student to begin with the simplest kind; those, for instance, which I have just mentioned. When habit has given dexterity in the combined management of the mirror and object-lens, the *binocular* ophthalmoscope, as invented by Giraud-Teulon, or some improved form of it, may be employed.

Before commencing a thorough examination of a case, it is necessary to dilate the pupil with atropine, unless it has become permanently dilated from disease. In many instances, however, a glance at the optic nerve and the parts adjacent is all that is required, and in that case it is unnecessary to subject the patient to the inconvenience of atropine.

The observer and the patient sit face to face in a room from which daylight is excluded; the only source of illumination being a lamp, or, still better, a jet of gas issuing from a jointed tube, so that the flame can be placed higher or lower, according to the height of the patient's head. The flame should be on a level with his eye, and just far enough behind him to prevent any of the direct rays falling on his cornea. The chimney surrounding the flame must be of transparent glass, and, if faintly tinged with blue, it will modify the red rays, and impart to them a whiteness nearly resembling that of ordinary daylight. The observer places the back of the mirror close to his own eye, so that he looks through the central aperture, and holds the instrument at such an angle that the reflected light from it falls into the patient's pupil. This is always very difficult for a beginner to accomplish, but a little practice soon makes it easy. He will know that he holds the instrument in the right position and at a proper distance from the eye, by seeing the fundus assume a brilliant reddish appearance.

Still holding the ophthalmoscope in the same position, he takes in the other hand a convex glass, of two inches or two inches and a half focus, and places it a little in front of the cornea. If the fundus of the eye be properly illuminated, and the convex glass correctly placed, some of the retinal vessels will now be distinctly seen. The observer is often confused by seeing a small bright image of the mirror reflected from the surface of the object-lens. This image can be got rid of by giving to the lens a slight inclination.

By turning the eye in various directions every portion of the retina is successively brought under the view of the observer. The necessity for varying the position of the eye constitutes a great objection to the more complicated ophthalmoscopes, which are fixed to a table or other support; and some eyes are so unsteady, and so little under the patient's control, that the observer is obliged to follow their movements by slight changes in the position of the ophthalmoscope, which can only be effected when the instrument is held in the hand.

There are two methods of examining with the ophthalmoscope—the 'direct,' and the 'indirect.' In the former method, the mirror must be brought very close to the patient's eye—an inch or two from the cornea—and the image of the retina then appears to the observer in its natural *erect* position. But this very close approximation to the patient is inconvenient; the side of the patient's head intercepts some of the light which ought to fall on the mirror; and only a limited portion of the retina, thus feebly illuminated, can be brought into view at one time. The direct method, therefore, is comparatively seldom employed, and chiefly for the purpose of examining in detail small portions of the fundus, which are seen in their true position, and considerably magnified.

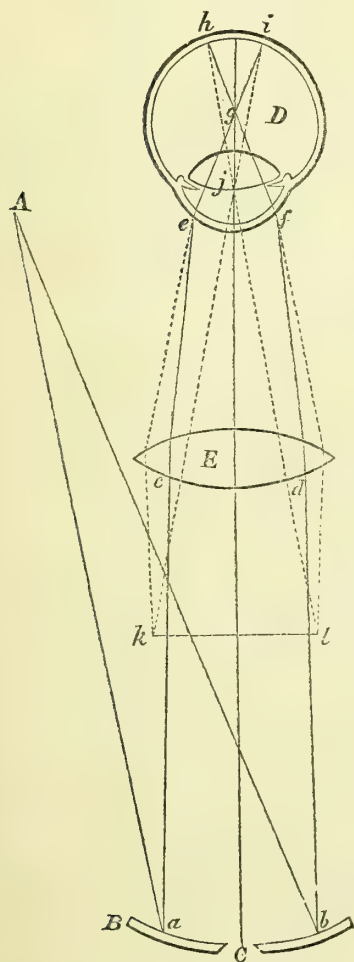
In the 'indirect' method, the mirror is held at a distance of several inches from the patient's eye, and a convex lens of short focus, two to two and a half inches, is placed a little in front of the cornea. In this way the inconvenient and obviously undesirable relative position of the observer and observed is avoided, the retina is more brilliantly illuminated than in the 'direct' method, and a good general view of the whole fundus is obtained. The image of the retina seen by the observer is an 'aërial' one, which is formed at a point between the convex lens and the ophthalmoscope, appearing there in an *inverted* position. This inversion of the parts examined must always be

borne in mind by the surgeon while employing the 'indirect' method.

The following diagram, copied from Zander's work, explains the mode in which the aërial inverted image is formed.

Within the narrow limits of the present essay, I cannot

FIG. 143.



A is the illuminating flame; *B* the concave speculum; *C* the aperture in its centre; *D* the patient's eye, before which is held a convex lens, *E*. From the flame *A* the rays *a b* fall on the speculum, and are reflected from it towards *D*. Striking the lens, *E*, at *c* and *d*, they acquire a greater convergence in passing through it, and fall upon the cornea at *e* and *f*. Traversing the patient's eye, they again converge, and, intersecting at *g*, form on the retina a 'circle of dispersion,' at *h i*. Reflected from the retina, in the direction of the dotted lines, *h, j, i, j*, they pass out of the eye, and being intercepted by the lens *E*, are again refracted, and form at *k l* an inverted image of the retinal surface *h i*, which is viewed by the observer's eye placed at *C*.

attempt to give more than a bare outline of the use of the ophthalmoscope. The literature of the subject is already overwhelming. One of the most complete treatises is that by Zander, just alluded to, *Der Augenspiegel*; Leipzig, 1859. It has been translated, and has undergone considerable condensation—

a process it greatly needed—by Carter, under the title of *The Ophthalmoscope, its Varieties and its Use*; 1864. There is also an excellent essay in French by Giraud-Teulon, contributed by him to the supplemental volume of Testelin's and Warlomont's translation of Mackenzie's great work.

Ophthalmoscopic Appearances of the Eye in a healthy state.

(Plate I. fig. 1.)

In the heading of this section I use the word 'healthy' with a certain latitude of meaning; for, apart from any serious disease, the mere advance of age imprints upon the internal tissues of the eye, certain changes of appearance, which, although deviating from an ideal standard of perfect health, can hardly be termed morbid. At present, I wish to present to the reader merely a sketch of what he is to look for in an eye which fairly performs its functions as an organ of vision.

Retina.—The observer must not expect to find this tissue presenting one uniform colour in all cases; the tint varies from pale red, through shades of red-orange and yellow-orange, to buff. In full-blooded persons, with a vigorous circulation, the retina would naturally have a much redder appearance than in those who are feeble and anæmic.* The colour of the retina is almost wholly due to the vascular choroid behind it; and the amount of redness transmitted from the choroid will depend upon the quantity and condition of the hexagonal pigment between it and the retina. Some ophthalmoscopists altogether object to our speaking of the colour of the retina, inasmuch as owing to its translucency, it allows the redness of the choroid to be seen. But no objection ought surely to be taken on this account to our familiarly applying the term colour to the retina itself.

Across the illuminated fundus of the eye the observer will notice large vessels radiating from a central point towards the periphery. These are the large branches of the central artery and vein of the retina; and by directing the patient to turn the

* These remarks apply only to patients as commonly seen in England. Among the darker tribes of mankind, the abundance of pigment gives to the fundus of the eye, both in health and in disease, shades of colour wholly different from those of the fairer races. For ophthalmoscopic appearances among the natives of India, see Macnamara's *Lectures on Diseases of the Eye*, 1866.

eye a little towards the median plane, the observer will be able to trace these vessels to their parent trunks in the middle of the optic nerve. The vessels of the choroid, as I shall by-and-by have occasion to notice, are so entirely unlike the radiating trunks of the retina, that a single examination will suffice to prevent any subsequent confusion between them.

It requires a little more practice to distinguish between the retinal arteries and the veins. If an arterial trunk be examined where it attains its greatest size, namely, at its emergence from the optic nerve, it will be seen to be of a paler red colour than the adjacent vein, and to present a double outline. The greater thickness of the arterial wall is the cause of both these peculiarities of appearance; for, of course, the colour of the contained blood is less plainly seen where the wall is thicker; and while the light, reflected from behind the artery, shines through it with subdued brightness, each side of the cylinder presents a line of shadow. The coats of the veins, on the other hand, are so thin, that they allow the colour of the blood to be plainly seen throughout the whole diameter of the tube. This distinction between the veins and the arteries of the retina becomes less marked as age advances. Simple inspection of a healthy eye does not detect any pulsation in the retinal vessels; but if the globe is firmly pressed with the finger, a decided pulsation may be seen, both in the arteries and veins.

If the patient looks directly forwards, a very important portion of the retina comes into view, namely, that occupied by the *macula lutea*, or 'yellow spot,' which corresponds to the axis of vision. The retinal arteries and veins deviate a little from their regularly radiating course as they approach the yellow spot, which therefore has no large vessel in its immediate neighbourhood. (Plate I. fig. 1.) Most observers, I think, must content themselves with making out the cloudy redness which indicates the position of the *macula lutea*, without actually seeing the dot which it forms. Liebreich gives a drawing (tab. ii. fig. 1) in which it is represented. I have, however, never succeeded in obtaining such a view of it as he depicts.

Optic nerve.—To bring the nerve into view, the patient must direct the eye a little towards the nose. No structure seen with the ophthalmoscope presents a greater variety of appearance than the optic nerve, even in patients who enjoy good sight. As age advances it becomes smaller, and often deviates more or

less from that circular outline which one may assume as the healthy standard.*

Contrasted with the reddish tint of the surrounding retina, the nerve appears cream-coloured, or it sometimes presents that faint tinge of pinkish-grey which we are familiar with in the cineritious portion of the cerebral convolutions. The extreme edge of the disk is often of a less decided white than the central portion.

From the centre of the nerve the main trunks of the retinal artery and vein are seen emerging. Commonly each vessel issues as a single trunk, which then divides into branches, but sometimes the division into two or three trunks takes place before the vessels quit the substance of the nerve in which they are imbedded. In some cases the vessels pass off at once to their destination, in nearly straight, or slightly wavy lines, while in other cases they form several abrupt curves on the surface of the nerve before quitting it.

Choroid.—This structure exhibits a great variety of appearances under the ophthalmoscope. The distinctness with which it is seen depends upon the degree of transparency of the retina, and the condition of the hexagonal pigment-cells behind it; and it seems that considerable variations in both these tissues are compatible with good sight.

In young persons the vessels of the choroid appear dim and indistinct, as if overspread with a thin semi-opaque film; but in old persons they are sometimes so plainly seen that the observer almost forgets he is looking at them through the whole substance of the retina. It is in old persons, therefore, that the peculiar arrangement of the choroidal vessels can be best studied. They are very much larger than the radiating vessels of the retina, and are closely packed together, leaving between them narrow, elongated spaces, in which dark pigment is visible. (Plate III. fig. 1.) During the earlier periods of life these vessels present a bright red, but in old age this colour often becomes mixed with a brownish tint.

* I have uniformly spoken of the *optic nerve*, instead of using the term 'optic papilla,' which some authors employ. No confusion can arise from applying the term *nerve* to that which is in reality only a part of the nerve, since no other portion than its extremity comes under our notice in using the ophthalmoscope. The term 'papilla' is objectionable too, as implying a *prominence*; and I believe the distal end of the optic nerve to be nearly, if not quite plane in a state of health.

CHAPTER III.

DISEASES OF THE CONJUNCTIVA AND ITS AREOLAR TISSUE.

(Ophthalmia ; Conjunctivitis.)

INFLAMMATION of the conjunctiva, I need hardly say, accompanies many of the inflammatory processes originating in other tissues of the eyeball. In the present chapter I confine myself to those cases in which the inflammation originates in the conjunctiva, and is either limited to it, or spreads only to the sclerotic.

Inflammatory redness differs very remarkably in these two structures. It is on the inner surface of the lids, and at their point of junction with the globe, that the conjunctival vessels are largest, and their redness is most strongly marked ; and the colour becomes paler as the vessels diminish in size on approaching the cornea. The sclerotic vessels, on the contrary, are most visible close to the cornea, around which they form a pink circle, known as the *sclerotic zone*—a very characteristic mark of several important forms of disease in the deep-seated tissues of the eye. Even if the sclerotic be uniformly injected throughout its whole extent, this injection cannot be traced very far back from the edge of the cornea, because the redness soon becomes hidden beneath the fibrous insertions of the recti muscles. The vessels of the sclerotic are small, closely set together, and so interlaced with the proper fibres of the part that the individual trunks cannot be recognised ; they merely produce the effect of a uniform tint of colour, nearly resembling that of carmine. The conjunctival vessels, for the most part, are plainly seen, and, except in that high stage of inflammation termed *chemosis*, they can be observed repeatedly to anastomose, so as to form a closely-set network.

Elaborate classifications of the various forms of ophthalmia are to be found in many of the systematic works on eye-diseases ; but minute distinctions, however plausible they may look on paper, are of little or no use to the practitioner. In selecting a few heads, under which to group the varieties of ophthalmia, I have been guided by the very decided peculiarities which certain forms present, or by the marked difference in the treatment they require. Most of the slighter forms of conjunctival

redness, not resulting from direct violence or the presence of foreign bodies, are due to atmospheric changes; and the cases described by authors under the name *simple ophthalmia*, are, for the most part, mild cases of catarrhal inflammation. When the sclerotic also is affected, the term *rheumatic* is sometimes added; and Mackenzie uses the words 'catarrho-rheumatic' to signify that both the conjunctiva and the sclerotic are inflamed, although the inflammation may be due to the mere external agency of cold, and not to the presence of rheumatic poison in the blood of the patient.

Slight attacks of redness of the conjunctiva are commonly attended with only trifling uneasiness. The enlarged vessels, projecting above the level of the membrane, suggest to the patient the notion of foreign bodies, sand or dust, between the lids and the globe. But in other instances, where the redness is very trifling, the pain is of a neuralgic character, and it is for the irritation existing in the ophthalmic division of the fifth nerve that the patient seeks medical aid. It is important for the practitioner to remember that in such cases the suffering may be really severe, although there is far less appearance of inflammation than in other cases where pain can hardly be said to exist.

Whenever a case of ophthalmia is seen for the first time, the margins of the lids and the puncta lacrymalia should be carefully explored, as a few irregular eyelashes, or even a single eyelash lodged in one of the puncta, may be causing the irritation.

It sometimes happens that a foreign body, lodged under the upper lid, sets up a considerable amount of ophthalmia, and yet the patient is not aware of any such cause of irritation being present. To evert the lid requires a certain amount of tact and practice. A probe, or the feather-end of a pen, just thick enough to resist bending, is to be laid horizontally across the lid, about half an inch from its free margin. The surgeon then grasps with his finger and thumb the eyelashes growing from the middle of the tarsus, and draws the lid away from the globe, while at the same moment he slightly depresses the probe or pen, and tells the patient to look downwards. The tarsal cartilage tilts over, and the conjunctival surface of the lid is exposed to view. The foreign body is almost invariably found within a line or two of the tarsal margin.

This simple eversion of the lid appears so obvious a method

of detecting foreign bodies, that one fancies it must have suggested itself to surgeons from the very earliest period ; and yet, as far as I can discover, it was for the first time made public by Ware, in 1787.*

When the surgeon has satisfied himself that the redness of the conjunctiva is not caused or kept up by any mechanical irritation, he is not at once to prescribe a lotion or drops as a mere matter of routine. I shall hereafter have occasion to speak of the invaluable properties of a local stimulant in cases of true *catarrhal ophthalmia* ; but at present I am considering those varying forms of conjunctival redness which are described by most writers under the name of *simple ophthalmia*. It is the surgeon's business to note well the general aspect of the patient : to ascertain what is faulty in respect of digestion, general nervous power, condition of the circulation ; whether the ophthalmia can be traced to over-use of the eyes, exposure to irritating or vitiated air, want of exercise, excess in the use of stimulants, tobacco, &c. ; in short, a rapid survey is to be taken of whatever is faulty in the patient's general health, and, in most cases, when this has been done, and the proper medical and dietetic means have been taken to correct what is amiss, the ophthalmia is already in a fair way of being cured.

As a rule, local congestion of the conjunctival vessels is met with in feeble and languid patients, who require tonics—iron, or quinine, or mineral acids, and a corresponding plan of diet. Of course there are many cases in which an excess of stimulants, and general over-feeding, have disturbed the due balance of the patient's circulation, and where a restricted and well-regulated diet is absolutely essential. But even in such cases a careful and moderate use of tonics is often necessary. What I wish to guard my readers against is the habit, which has been handed down to us from early times, of regarding all inflammations of the eye as necessarily to be treated by depletion, leeches, and low diet. The very reverse of this is the truth. The popular notion that a leech or two to the temples, and a purgative, must needs cut short an attack of inflammation in the eye is shared by only too many of the old school of practitioners. In young children especially such treatment is most

* *Remarks on the Ophthalmia*, &c. p. 23.—I have thought it well to repeat, in this place, directions already given under another head, at p. 17.

mischievous. From the age of one or two years up to puberty, ulceration of the cornea is what we have most to fear, and this is sometimes attended with so slight a degree of redness of the conjunctiva and sclerotic, that it is important for the surgeon to be aware of this fact, and not to overlook slight attacks of ophthalmia in such subjects, but in every case to look carefully to the condition of the cornea.

While I so strongly insist on the great importance of general treatment in ophthalmia, I by no means exclude the use of local remedies. Where much intolerance of light exists, a small blister to the temple, or the application of tincture of iodine to the skin of the upper lid, will often afford great and immediate relief. Bathing the eyes night and morning with warm water is of great use in some irritable patients; while, in other cases the use of cold water is indicated. Those persons especially who have induced a congested state of the conjunctival vessels by prolonged exposure to artificial light, are often greatly relieved by a plentiful sluicing of the closed lids with cold water night and morning. Where there is agglutination of the lids during sleep, a little spermaceti, or perfectly fresh olive-oil, may be smeared on the eyelashes at bedtime. Weak solutions of acetate of lead or alum (two, three, or four grains to an ounce of distilled water) are useful in chronic cases; but they should be used sparingly, and never for too long a time. After a few days they should be left off, and the part allowed to recover its natural tone, the stimulant being resumed if necessary; but it should never be uninterruptedly continued for weeks or even months, as patients are only too fond of doing.

There are certain forms of ophthalmia which present such distinctive characteristics that they are very properly known by special names. Such are the *Catarrhal*, the *Purulent* (including the *Infantile* and the *Gonorrhæal* forms), the *Pustular*, and the *Chronic*. The disease commonly termed *Scrofulous Ophthalmia* should rather be classed among the diseases of the cornea; and the same may be said of the *Exanthematous* ophthalmia of authors; for it is the cornea which chiefly suffers, either by ulceration or sloughing, in consequence of the low state of vitality following the various forms of exanthematous disease. The term chronic, although of course applicable to any slow and protracted form of disease, when applied to ophthalmia is usually understood to mean an affection of the palpebral conjunctiva, the caruncle and semilunar fold, and the margin of the lids,

which is either developed as an independent disease, or remains as a sequela of an acute attack of catarrhal or purulent inflammation.

CATARRHAL OPHTHALMIA.

This is commonly caused by exposure to draughts of cold air, but it is by no means limited to the cold season of the year. It frequently attacks large numbers of persons during the extreme heat of July or August, especially if, as often happens, an east wind prevails at the same time.

A well-marked case of catarrhal ophthalmia presents the following appearances: the cornea is quite clear, and vision is unimpaired, or only occasionally obstructed by the passage of thickened mucus across the area of the pupil. The conjunctiva of the lids is redder than natural, and the injection is particularly marked at the point of reflection of the conjunctiva from the lower lid to the globe. The semilunar fold and caruncle are red and much swollen, especially the former, and this enlargement of the semilunar fold often remains long after all other traces of the ophthalmia have subsided. The surface of the globe presents a network of vessels which gradually becomes less marked as it approaches the cornea. In some cases the sclerotic is involved, and then the peculiar pink zone is seen reaching close up to the margin of the cornea.

A peculiar characteristic of true catarrhal ophthalmia is the existence of numerous red blotches at various parts of the network of vessels, caused by some of these having given way and allowed their blood to become extravasated. The extravasations vary much in size; some are as small as a pin's head, others almost equal the breadth of the cornea.

At the commencement of the attack there is little increase of secretion; subsequently, mucous secretion sets in, which in some cases becomes so profuse as to make the surgeon suspect that the case may be one of true purulent ophthalmia.

There is usually no acute pain in common catarrhal inflammation; but a sense of weight and stiffness in the lids, and, as the disease advances, the enlargement of the vessels suggests to the patient the notion of sand or some other foreign substance between the lids and the globe.

When the sclerotic is much involved, there is usually intoler-

ance of light, and much secretion of tears, and pain either of a dull aching or of an acute darting character. The upper lid, too, frequently becomes oedematous in cases of this mixed kind of sclerotic and conjunctival inflammation, and the infiltration of the subconjunctival cellular tissue raises the conjunctiva above the level of the cornea, so as even sometimes to overlap its margin. This elevated condition of the inflamed conjunctiva is termed *Chemosis*.

I need hardly say that a patient who is the subject of catarrhal ophthalmia is frequently disordered in general health, with confined bowels and disturbed digestive functions, and may require appropriate treatment by internal medicines; but very often the ophthalmia comes on without any general ailment, and seems a purely local affection, even limiting itself in some instances to one eye.

Treatment.—When the ophthalmia is unattended with constitutional disturbance, and is confined to the conjunctiva, the local application of nitrate of silver in solution may be regarded almost as a specific. It should be used in the proportion of two grains to the ounce of distilled water, and dropped upon the surface of the eye twice or thrice a day, the conjunctiva being cleansed, by bathing it with warm water, before each application of the drops. At bedtime the eyelashes should be anointed with a little spermaceti-ointment or olive-oil. Care must be taken not to continue the use of the drops too long. After being used for a week, they may be omitted for a couple of days, and then resumed as before, if the inflammation appears unsubdued; but often it will be sufficient, after a week's application as above described, to use the drops for a few days longer once a day. In uncomplicated cases, ten days or a fortnight will suffice for the cure; but, if the disease spreads to the sclerotic and cornea, the nitrate of silver must be omitted. The caruncle and semilunar fold are the last to recover their healthy condition after an attack of catarrhal ophthalmia. I have said that the treatment by nitrate of silver is to be adopted when the inflammation is *limited to the conjunctiva*; and it is from want of attention to this point that so much mischief is constantly done. Whenever the sclerotic is much inflamed, and, still more, whenever the cornea is in the least degree implicated, nitrate of silver does nothing but harm.

PUSTULAR OPHTHALMIA.

This is a very common form of ophthalmia, especially among children and young persons. It is characterised by little, reddish,* apthæ-like elevations on the conjunctiva, close to the edge of the cornea, each surrounded by a plexus of blood-vessels. The centre of the little elevations is less vascular, and therefore whiter, than the base, and hence their appearance is a good deal like that of a pustule; but they do not contain pus, and the term 'papular ophthalmia' would be more appropriate than 'pustular.' When only one or two of these so-called 'pustules' are present, they are usually found upon the equator of the eyeball; but sometimes they are more numerous, and almost surround the cornea. They are seldom attended with much pain, or intolerance of light, unless the sclerotic be also inflamed. In true pustular ophthalmia the cornea never suffers, although, from the redness extending close up to its margin, patients are often alarmed at the prospect of the disease affecting the sight.

Vascular elevations similar to those of common pustular ophthalmia sometimes accompany the irritable form of corneal inflammation improperly termed 'Scrofulous Ophthalmia.' In such cases the intolerance of light may be very great.

Unless there be some derangement of the general health, the treatment of pustular ophthalmia is very simple. A weak solution of acetate of lead—two, three, or four grains to the ounce of distilled water—may be used twice or thrice a day; or, if the inflammation be extensive, and the 'pustules' numerous, a blister to the temple should be applied before the lotion is resorted to.

PURULENT OPHTHALMIA.

(*Suppurative Ophthalmia; Ophthalmoblenorrhœa; Conjunctivitis puro-mucosa; Ophthalmia contagiosa; Egyptian Ophthalmia; Ophthalmia bellica; Military Ophthalmia.*)

On arriving at the consideration of this form of ophthalmia, we must no longer confine our attention to the conjunctiva; for although it is in this tissue that the disease commences, it derives all its importance from the fact that the *cornea* is liable to

* It was termed by Morgan 'Apthous Ophthalmia.'

become involved. Much has been written upon the essential differences subsisting between the common purulent ophthalmia of adults, that affecting infants, the Egyptian, and the gonorrhœal ophthalmia; but these various forms, in certain stages of their progress, often resemble each other very closely, so that a severe case of common purulent ophthalmia cannot be distinguished from one of gonorrhœal origin: and the purulent secretion from the eye of an infant suffering from *ophthalmia neonatorum*, if applied to the eye of an adult, may set up all the phenomena of the truly gonorrhœal form. We must not expect, therefore, to be able in every instance to say with certainty, the first time a patient comes before us, 'This is simple purulent ophthalmia;' or, 'This is of gonorrhœal origin;' we must wait until we have had time to watch the progress of the case.

If a patient presents himself in an early stage of purulent ophthalmia, we may, as I have said, be unable to distinguish the disease from the simple catarrhal form; but should the purulent ophthalmia have reached its height, we should find the following appearances.

The patient is generally pale and depressed; the lids are of a dull red, inclining to purple; they are swollen and œdematous, often to such an extent as to prevent the patient separating their margins in the smallest degree. When the surgeon draws them apart, thick yellow secretion oozes from the conjunctival surface, and if allowed to dry, forms a crust, which almost hides the eyelashes from view. The inability to open the eyes very naturally induces the patient to believe that he is blind, and this belief tends still further to depress him both in body and mind. To separate the lids, to cleanse the cornea from the secretion which overspreads it, and thus to give the patient a glimpse of surrounding objects, is often the best means of raising his general powers.

In a case of extreme inflammation, such as I am now describing, the conjunctiva covering the globe is reddened, infiltrated with serum, and raised to a considerable extent above the surface of the sclerotic. This is especially the case immediately around the cornea, the conjunctiva being thrown up into a roll which overlaps the corneal margin. This raised condition of the inflamed conjunctiva constitutes what is termed *chemosis*—a very characteristic mark in this and other forms of severe inflammation. In exploring the surface of the cornea, the surgeon should not content himself with merely cleansing it

from secretion by means of a bit of wetted lint or sponge ; but with a probe or little spatula he should carefully lift up the overlapping portion of the chemosis, in search of any hidden ulcer ; for it is at the extreme edge of the cornea that the ulceration sets in, which may eventually go on to perforation.

The milder cases of purulent ophthalmia stop short of the ulcerative stage ; and under appropriate treatment the puriform secretion ceases, the conjunctiva gradually loses its unnatural vascularity, and regains its healthy aspect.

The severer cases terminate either in *ulceration* or *slough* of the cornea. The ulceration usually begins, as I have said, at the corneal margin, and as it extends assumes the form of a more or less deep crescentic groove. Then the ulcer perforates the cornea at some point, and a portion of iris prolapses, producing the appearance of a small dark-coloured nodule at the bottom of the ulcer.

Of course any protrusion of the iris must cause deformity of the pupil, which becomes pear-shaped, oval, or reduced to a narrow slit, in proportion to the amount of iris which has escaped through the ulcer. Sometimes the ulceration spreads as a deep groove quite around the margin of the cornea, so as to isolate its central portion, which stands out in relief, cloudy or wholly opaque. Eventually this central portion becomes involved in the ulcerative process, and then the whole cornea becomes thinned, so as to yield to the pressure of the contents of the globe, and forms a bulging mass made up of the remains of the corneal tissue, between the fibres of which dark-coloured portions of exposed iris protrude. At a later period the surface becomes traversed by ramifying blood-vessels. This wholesale destruction of the cornea, however, rarely occurs except in cases of gonorrhoeal inflammation. Sometimes purulent ophthalmia, instead of inducing ulceration, ends in *sloughing*. In that case the chemosed conjunctiva encroaches a good deal upon the surface of the cornea ; the latter becomes hazy, then opaque and yellowish, and quite dull on the surface ; at last it looks almost like a piece of wash-leather, then softens and comes away in shreds ; the whole iris bulges forwards, and becomes coated with a fibrous exudation, which eventually transforms the part into a *staphyloma*.

Purulent ophthalmia can undoubtedly be transferred from one person to another by contact with the secretion. Patients, therefore should be cautioned on this point, as also their nurses

or attendants. It seems probable that in hot countries, where this ophthalmia is very prevalent, the flies act as propagators of the disease. The dust also of those countries, by keeping the conjunctiva in a state of chronic irritation, no doubt predisposes to the attack. In England the disease, like the common catarrhal form, is, I think, most frequent during the extreme heat which sometimes visits us in July or August, if it be attended, as is often the case, with an east wind.

Treatment.—Although the more rational practice of the present day has effected a vast reform in the treatment of so-called inflammatory diseases, both internal and external, the force of old prejudice and habit has, to a great extent, prevented medical men from applying the same reasoning and common sense to the treatment of eye-diseases which they apply to those of other organs of the body. And, indeed, if a practitioner, unaccustomed to meet with ophthalmic cases, turns in his difficulty to many a work of high authority, published in his own day, he finds such a system of depletion recommended for purulent ophthalmia as is positively frightful.

Purulent ophthalmia, in its severe form, is usually met with in patients who are irritable, pale, and depressed. And this is almost certain to be the case if the disease be seen at an advanced stage; for the popular notion of the disease, and indeed, of nearly all diseases of the eye, is, that depletion of every kind is the only way to combat them. So true is it, that the vulgar errors of to-day are but the solemn medical dicta of our forefathers.

If the patient's bowels have been well relieved, the first requisite is usually a narcotic at bedtime. I almost always give tincture of hyoscyamus, mxxv . or 3ss. or even 3j. in camphor-mixture, unless the patient has been habituated to the use of opium, when a moderate dose of that drug may be preferable. It is not easy to lay down positive rules for diet, but it should be such as is best calculated to keep the patient's vital powers to the level of ordinary health; as much of plain nutritious food being taken as the stomach can digest, and just such an amount of stimulants as will aid digestion, and maintain the due vigour of the circulation. Quinine is almost always useful in suitable doses. In short, ulceration and sloughing of the cornea should be combated or guarded against, just on the same principles as those destructive processes would be combated in any other tissue of the body. To a delicate,

ill-fed, over-worked woman, attacked with acute purulent ophthalmia, it may be necessary, in addition to a little beer at her dinner, to order a glass of wine twice or thrice a day. To a person in a comfortable position in life, the ordinary amount of stimulants may be amply sufficient, while, with one habitually intemperate, a considerable diminution of the accustomed quantity may really effect the desired object, by avoiding that after-depression of the nervous system which invariably follows over-indulgence in drink.

The local treatment of purulent ophthalmia consists in the frequent employment of astringents, such as alum, nitrate of silver, or tannin, dissolved in distilled water. The alum may be used in the proportion of eight or ten grains to the ounce, and applied by means of a fine soft rag, every hour during the day, and as often during the night as is compatible with the patient's rest. Where the surface of the globe can be well exposed by drawing down the lower lid, it may suffice to dab the surface of the palpebral conjunctiva and to squeeze the lotion over the surface of the eye from the rag or a fine sponge. If there be so much swelling of the lids as to make it impossible to expose the surface of the globe, the lotion must be injected beneath the lids with a syringe, first throwing in a little warm water to clear away the discharge. As the case improves, the lotion may be used less frequently, every two or three hours. If nitrate of silver be employed, it should be in the proportion of three or four grains to the ounce, and be dropped upon the surface of the globe three or four times a day, after syringing away the discharge with a little warm water. Tannin dissolved in distilled water may be used as a substitute for the alum. In some severe cases which assume the violence of the gonorrhœal form, ulceration rapidly extends along the edge of the cornea—usually the lower edge—in the form of a deep crescentic groove. Unless speedily arrested, it penetrates the thickness of the cornea, and if the opening into the anterior chamber be large, so much of the iris may prolapse as greatly to diminish, or wholly to annihilate the pupillary aperture. In such cases it is sometimes possible to check the spread of the ulcer by rapidly passing over its entire surface a fine point of nitrate of silver. A fine probe, coated with the fused salt, is usually the best means of application.

I need hardly allude to the great importance of pure air in the disease now under our notice. In fine weather it is not

necessary, even during the acute stage, wholly to confine the patient to the house ; and when the ulceration is arrested, and the purulent discharge has ceased, careful and judicious change of air will tend more than anything else to remove the chronic ophthalmia, which is otherwise apt to linger on for a long period.

GONORRHOEAL OPHTHALMIA.

This disease is essentially the same in character as the preceding ; but is far more severe and destructive. It is caused by gonorrhœal matter coming in contact with the conjunctiva ; and among the more ignorant classes it is sometimes the result of a very prevalent vulgar error—that a sovereign remedy for sore eyes is to bathe them in the patient's own urine.

I know of no symptom by which we can positively distinguish ordinary purulent ophthalmia from the gonorrhœal form, provided the two diseases are seen at an early stage. Many authors speak of gonorrhœal ophthalmia as almost invariably confining itself to one eye ; but this is certainly not the case ; and I could relate many instances in which both eyes were attacked within a few days of each other. Indeed, it seems strange that this is not the rule rather than the exception.

Gonorrhœal, like ordinary purulent ophthalmia, begins with redness of the conjunctiva, and a sensation of sand beneath the lids. After a few hours muco-purulent discharge sets in, and the ocular portion of the conjunctiva becomes infiltrated with serum. This thickening rapidly increases and forms a *chemosis*, which is always a very marked symptom in gonorrhœal cases. At the same time the lids become red, and so much swollen that the patient can separate them to only a very slight extent. The cornea becomes hazy ; and at this stage an ulcer is almost certain to be found at its margin. Sometimes ulceration begins while the rest of the cornea is still clear ; and in that case some care is necessary to detect the loss of substance. A thorough examination of an eye at this stage of the disease cannot be made without the aid of the wire speculum, which prevents the swollen conjunctiva of the lids from bulging over and hiding the cornea. If the margin of the cornea be overlapped by chemosis, a probe or little spatula should be used to hold it aside, while the surface of the extreme edge of the cornea is wiped perfectly clean with a bit of wetted lint or rag.

Patients affected with gonorrhœal ophthalmia are almost

always in a state of depression, with weak pulse and deranged digestion. This condition is partly due to the local disease itself, and partly to the distress of mind caused by the fear of impending blindness. It seems extraordinary that surgeons of eminence can have been so far misled by theoretical notions about 'inflammation' as to have overlooked the general condition of these patients, and to have treated them by frightful bleedings, mercury carried to salivation, and other depressing means. Those of my readers who may imagine that the so-called 'antiphlogistic' plan of treating gonorrhœal or severe purulent ophthalmia belongs to the remote past, need only turn to the works of those who, thirty or forty years ago, were the great authorities of ophthalmic practice, to find that profuse bleeding, mercurialism, and a diet just stopping short of actual starvation, are enjoined as the best means of arresting ulceration and sloughing in the eye; while the very same authorities would have condemned, as *mala praxis*, such treatment of similar morbid processes in the arm or in the leg. One author tells us, that 'the *only case* of gonorrhœal ophthalmia he had seen in which the eye was saved was that of a young woman, in whom venesection was repeated as often as blood could be got from the arm. She lost 170 ounces of blood in a few days, and looked as if every drop of blood had been drained from her body, the skin having nearly the hue of a wax-candle.' One would have thought that the adage, *exceptio probat regulam*, would have occurred to this surgeon's mind, and that he would have regarded a system as self-condemned under which *only one* eye had escaped destruction. But he never seems to have had the slightest suspicion that the system could be wrong.

A second authority quotes, among other cases, the case of a young man who, on the first day, had been bled to fainting, then vomiting was kept up by tartar-emetic as long as it could be borne. In the evening, the pain in the eye had become worse; he was bled again. On the following morning the swelling of the lids was greatly increased, so that the eye could not be seen, and there was copious yellow discharge; the night had been passed in severe pain, which entirely prevented sleep. Bleeding was repeated twice more: blood was taken, by cupping, from the back of the neck and the temple, and leeches were applied around the eye in large numbers; 'but although the free use of purgatives and antimonials, with low diet, was combined with these measures, no sensible effect was produced

in diminishing the violence of the inflammation, or arresting its progress.' Still no misgiving as to the soundness of the system! A third surgeon tells us, that 'the lancet must be hardly ever out of our reach; for if ever there was a disease in which blood may be taken away without limitation, it is this.' A still later authority, in a bulky text-book, written little more than thirty years ago, says: 'You will deem it necessary to bleed at the outset of the attack most freely; it would be almost criminal to stop the flow of blood until your patient exhibited symptoms of faintness; and as soon as he rallies, and the pain returns, the operation should be repeated until syncope is again produced. At the same time you would prescribe a liberal dose of calomel and jalap, so as to act freely on the bowels, and afterwards the tartarised antimony in sufficient quantity to maintain a state of decided nausea. You would also freely scarify the conjunctiva, . . . taking care to divide the texture of the conjunctiva at each sweep of the knife, so as to penetrate as far as the fluid effused into the subconjunctival cellular membrane. Bleeding from the conjunctiva is to be encouraged. A weak alum-lotion is to be used, and the diet is to be limited to light fluid aliment.' An injunction hardly necessary, since one cannot see how a man who has been kept in a state of perpetual nausea is to retain any food at all. But the patient is not to escape with only this amount of depletion. 'You would proceed to apply a quantity of leeches just below the tarsal margin of the lower eyelid, and direct the application of a blister between the scapulæ. Lastly, it may be necessary to use tonic and stimulating lotions, . . . and to employ a restorative regimen to reinvigorate the reduced powers'! Powers, be it observed, which have been reduced by the surgeon himself. We are to pull the house down, and then try to build it up again.

I may be told, that it is useless to bring forward such cases as these; that the current of medical opinion is changed, and that it now sets strongly against bleeding and depletion, and rather towards a tonic and stimulating plan of treating diseases. I am glad to acknowledge that such is the fact; but, by some strange fatality, the arguments which are allowed to apply to other diseases are still, to a certain extent, ignored so soon as diseases of the eye come to be treated. Some of the works from which I have quoted are still referred to by those who have only occasional opportunities of seeing cases of gonorrhœal

ophthalmia, and I cannot therefore think it superfluous to warn my readers against this system of Sangrado-like depletion.

Even Tyrrell, who in his treatment of other diseases laid so much stress upon supporting the powers of the patient, seems in the instance of gonorrhœal ophthalmia to have followed the track of his predecessors as to bleeding. He introduced a new method of scarifying the conjunctiva, which he believed to be destined to effect a total change in the treatment of the disease. It was founded upon the theory that the cornea perished by sloughing; that this sloughing was caused by fibrinous effusion beneath the conjunctiva immediately surrounding the cornea, whereby the vessels supplying the cornea were compressed, and their circulation impeded. He assumed that the cornea derived the whole of its nutrition through blood-vessels passing into it from the conjunctiva, and quite ignored the fact of any vessels passing to it from the sclerotic, and he would have utterly repudiated the notion of there being such a substance in the human body as a non-vascular tissue. The elevated roll of conjunctiva, constituting what is called the chemosis, was to him the great source of danger, and this was to be freely divided by means of radiating incisions, so as to allow the effused fibrin to escape, and the vessels supplying the cornea to be relieved from pressure. The anatomical mistake upon which Tyrrell's practice was founded was well exposed at the time by Wharton Jones.

The fact is, that the cornea, in severe cases of gonorrhœal ophthalmia, does not simply perish by sloughing, in the same way as a tumour strangulated by a ligature perishes. Ulceration first attacks the extreme edge of the cornea, in the manner I have described at page 35, and extends in a crescentic form until a considerable portion of the cornea has been cut off from its nutritive supply, and then of course it loses its vitality. In some cases, I have seen the ulceration extend all round the corneal margin; and then the central isolated portion, having previously become opaque, has rapidly assumed a softened pulpy appearance, and come away in shreds. The chemosis, which has been so much dreaded as the active agent in the destruction of the cornea, is merely formed by the infiltration of serum from the overloaded blood-vessels into the subconjunctival cellular tissue. Of course chemosis is an important symptom whenever it occurs, because it proves a congested condition

of the blood-vessels of the conjunctiva, with which there is generally associated a congestion of other more important tissues; but to reduce the patient's vital powers by bleeding, mercury, and low diet, and then to expect to save the cornea by cutting the conjunctiva, appears to be utterly irrational, and opposed to the first principles of physiology and common sense.

In speaking of purulent ophthalmia (page 36) I have anticipated the treatment of the gonorrhœal form. It is quite impossible to lay down positive rules as applicable to all cases. Each case becomes a study in itself, and according to the patient's constitution, habits, station of life, and previous treatment, must the surgeon modify his plan. To maintain the digestive functions, to administer suitable quantities of nourishment, to sustain the circulation at a proper point of vigour, neither unnaturally exciting it to hurried action, nor allowing it to flag, and so lead to local congestion of blood, and consequent deterioration of tissues—to secure as far as possible pure air at an equable temperature, to soothe the nervous system, and promote sleep by such mild narcotics as shall not confine the bowels or induce subsequent depression—such is the outline of the general treatment to be pursued.

The local applications I have already indicated at page 37, only I would lay still greater stress, in cases of gonorrhœal ophthalmia, upon the utility of nitrate of silver, applied in substance to the surface and edges of the crescentic ulcer. Unless this application be made with great care and neatness of hand, it may do more harm than good. A stick of nitrate of silver can hardly be pointed so sharply as to answer the purpose, and a fine probe, upon the end of which a small portion of the salt has been fixed by fusion, is to be preferred. The lids being held apart with a wire speculum, and the edge of the cornea having been wiped clean, the fine point of nitrate of silver is to be lightly passed over the whole surface of the ulcer. This application may require to be repeated after a couple of days, but should not be persevered in after the ulceration has ceased to spread.

In spite of all our efforts and care, it must frequently happen that cases of gonorrhœal ophthalmia terminate in loss of sight. For the disease often occurs in unhealthy subjects, weakened by intemperance and debauchery, and who, before they apply to a regular practitioner, have probably been in the hands of quacks, whose only remedy is mercury. Still, when we con-

sider of what immense importance it may be to retain even a small portion of the cornea in a transparent condition—thereby enabling the surgeon at some future time to make an artificial pupil, and so rescue the patient from blindness—we ought never to give up a case of gonorrhœal ophthalmia so long as any portion of one cornea retains its vitality.

GRANULAR CONJUNCTIVA.

(*Granular Lids; Trachoma.*)

One of the most serious sequelæ of purulent ophthalmia, whether of the simple or the gonorrhœal form, is that condition of the conjunctiva termed ‘granular,’ involving a hazy and vascular state of the cornea. During the progress of purulent ophthalmia, the palpebral conjunctiva, when cleansed from secretion, appears villous; and, after the purulent discharge has ceased, this condition of the membrane goes on increasing, until its surface resembles that of a granulating ulcer. The so-called ‘granulations,’ however, are in reality the follicles and papillæ of the conjunctiva, enlarged by inflammatory deposits. The firmness and solidity of these ‘granulations’ vary much in different subjects. When hard, and of considerable size, they cause irritability and blinking of the lids, and lachrymation, and after a time the cornea, especially its upper half, becomes hazy, and is traversed by numerous large vessels, forming in some cases a complete network, and giving an almost fleshy aspect to the part (*pannus*).

Treatment.—The granulations were long since recognised as causing by their friction the chronic inflammation and vascularity of the cornea; and accordingly, a great variety of plans have at various times been adopted for removing the granulations, and restoring smoothness to the palpebral conjunctiva. Complete excision with the knife or scissors, the rapid action of escharotics, and the more gradual wasting by means of astringents, have all in turn been employed against granular lids.

Effectually to cut away the granulations requires such extensive removal of the palpebral conjunctiva as is likely to induce permanent curving of the tarsus and consequent entropion; and the same result may follow the free employment of nitrate of silver. The ordinary astringent lotions of alum, tannin, &c. are powerless in the more severe cases. I have seen much

benefit from the acetate of lead, applied by dusting it, in fine powder, over the everted lid. This causes a good deal of pain at the time, but afterwards gives decided relief, apparently by mechanically filling up the interstices of the elevations, and so producing a smooth surface for the eyeball to move upon. The salt, as it slowly dissolves, seems also to exert an astringent effect upon the vessels of the enlarged follicles and papillæ, and so to diminish their bulk. But the most effectual means I have ever tried for removing granulations is the undiluted liquor potassæ, applied by dabbing it upon the everted lids, on which it seems to act by chemically saponifying and dissolving away the hypertrophied tissue. The application may be repeated at intervals of a few days; and six or seven weeks of this treatment will sometimes suffice to remove the granulations, and, at the same time, to restore a considerable degree of clearness to the cornea.

But, every now and then, cases are met with in which the cornea is so opaque, and so traversed by large blood-vessels, as to prevent useful vision, even when the granular state of the lids has been almost subdued. Such instances of opaque and vascular cornea follow severe purulent ophthalmia, especially the form so common in the East, and known to us as Egyptian ophthalmia. Cases of almost equal opacity are met with at our London hospitals, among the more destitute Irish patients. It appears that a very severe form of purulent ophthalmia is sometimes epidemic in certain districts of Ireland, rivalling in virulence the disease of tropical countries.*

Patients who have been a long time suffering from granular lids in a severe form are almost invariably out of health; often reduced by the violent courses of medicine they have undergone, and with the eyes in an irritable condition from long-continued use of caustic applications. To place such patients, if possible, in a pure and bracing air, and to improve their general health by suitable tonics, will be the first indications for treatment. Caustics and stimulants should be laid aside, and counter-irritation employed by means of small blisters to the temple, and tincture of iodine to the skin of the lids. In this way considerable improvement may be induced both in the condition of the

* Power, in a pamphlet on the Egyptian Ophthalmia, published in 1803, describes a species of the same disease as being 'frequently prevalent among the Irish peasantry, and considered by them to be infectious.' See also a paper by Wilde in the *London Journal of Medical Science*, vol. iii. 1851.

lids and of the cornea; but there will still remain certain inveterate cases, incurable by any ordinary treatment, either local or general. They usually present a granular condition of the palpebral conjunctiva; this, however, may have been got rid of, or greatly subdued, by treatment; the characteristic sign, which makes the disease so formidable, is the haziness and vascularity of the cornea.

We will suppose a case in which the granular condition of the lids has been partially or wholly cured, and the general health restored; but where, after exhausting every resource of his art, the surgeon still finds the patient's corneæ permanently opaque, and traversed in all directions by vessels, vision being limited to the mere recognition of large objects. There may be every reason to believe that the tissues of the eye posterior to the cornea still remain healthy, and yet the condition of the latter destroys all hope of good vision being regained.

For such desperate cases a seemingly desperate remedy—*inoculation*—has been proposed, consisting in the production of a fresh attack of purulent ophthalmia, by applying to the conjunctiva some morbid secretion from the eye of a patient suffering under the acute form of that disease.

This treatment was extensively tried in Germany several years ago, but seems to have fallen into disuse, and only of late to have been revived. Its advocates asserted that purulent ophthalmia, thus produced in an eye which had previously undergone the disease, would cause a wasting of the vessels overspreading the cornea, and ultimately restore its transparency. There seemed, however, a great risk of the second attack proving as severe as the first, and ending in destructive ulceration of the cornea; and the fact of the inoculation serving to keep up and perpetuate a dangerous and contagious disease, also operated with many surgeons as a reason for wholly discountenancing the practice. These considerations for some time induced me to abstain from the experiment. I had seen cases in which inoculation was followed by perforating ulcer of the cornea; but, at the same time, I had seen others in which considerable clearing of previously opaque corneæ took place without any ulceration whatever.

The first case in which I tried inoculation was one which seemed peculiarly suitable for it. The patient, a discharged soldier, was in good general health, but quite helpless in consequence of the state of his corneæ. They were so hazy that the position of his pupils could not be traced, and were traversed in

every direction by vessels. He had perception of reflected light and colours, but could not distinguish a hand from a sheet of paper, except by the difference of tint. Although the granular state of the lids had been nearly subdued, the condition of the corneæ during three years had been proof against every mode of treatment.

Some pus from the eye of a patient with purulent ophthalmia was applied to each conjunctiva. Intense inflammation set in, and on the third day there was already chemosis with thick purulent discharge. A week later, both corneæ were so covered with a yellowish flocculent layer as to appear to be in a state of complete slough. This substance, however, in the course of a few days, had disappeared, and the corneæ were found to be entire, presenting a somewhat translucent aspect, although the chemosis and discharge still continued. As no local application except cold water was permitted, and no astringent used to control the discharge, it continued in a slight degree for some months. Meantime the corneæ, as they became clearer, presented but few traces of the vessels by which they had been so plentifully traversed. Six months after inoculation, the patient could recognise features at a distance of twelve feet, and with perfect security could go about the streets of London alone. There still remained such a degree of haziness about the centre of each cornea as prevented him from reading ordinary type, No. 16 of Jæger's specimens being the smallest characters he could readily make out.

I have since used inoculation repeatedly, and so many cases have been reported by others, that I should not have quoted this single case, except on account of its bearing upon a point which I think has not been sufficiently attended to, namely, the varying results of inoculation in respect of its inducing corneal ulceration.

The vitality of the cornea is put to a very severe test when the suppurative inflammation sets in with such intensity as is exemplified in the case just mentioned. If the cornea be abundantly supplied with blood by vessels traversing it in every direction, it will probably resist both ulceration and sloughing; whereas, a simply opaque and non-vascular cornea may be destroyed, or at least perforated, on account of mere deficiency of blood-supply. The abundant vessels which had prevented the cornea duly performing its function of transmitting light, serve to keep it alive while the inflammatory stage is going on, and so enable it eventually to recover its transparency and usefulness. The very circumstance, therefore, of the cornea being in a hyperæmic condition is favourable, as regards its ability to support the violent means employed for the restoration of its transparency.

Those who for the first time resort to inoculation in a case of corneal opacity, resulting from bygone purulent ophthalmia, will probably be dismayed when they witness the immediate result of their experiment; and will give up the cornea for lost

when they see it overlapped and nearly hidden by chemosis, and catch a glimpse of its dead-yellow, slough-like surface. This, however, becomes detached, and leaves beneath it a translucent cornea, which, provided it has been well nourished with blood, may gradually advance in clearness, until it almost loses the marks of its former degeneration.

Throughout the treatment no attempt is to be made to arrest the discharge, cold water only being used as an external application in cleansing the eye. The patient should be allowed a nutritious diet, and on no account undergo depletion.

Even under the most favourable conditions, as regards the patient's general health, and the blood-supply of the cornea, inoculation must be a hazardous experiment; and it should, therefore, be reserved for those cases where the vascular opacity of the cornea has bidden defiance to all other forms of treatment, and has deprived the patient of all useful sight.

PURULENT OPHTHALMIA OF INFANTS.

(*Ophthalmia neonatorum*.)

This disease is closely allied in its symptoms to that just treated of, although not arising from the same specific form of infection.

Both diseases derive all their importance from the liability of the *cornea* to become ulcerated. The cause of *ophthalmia neonatorum* has given rise to much controversy; some regarding it as only an aggravated form of catarrhal ophthalmia, while others consider it as in every case due to contamination with the vaginal discharge of the mother. The latter is perhaps the more probable explanation, the difference in the intensity of the disease depending upon the more or less virulent nature of the discharge.

The ophthalmia begins a few days after birth. It may not for some time assume any intensity, and hence it is often overlooked in its early stage; and we are told that it did not begin till the child was two or three weeks old. When the child is jaundiced, the discharge assumes a deep yellow colour.

The surgeon's first object should be to ascertain to what extent the *corneæ* are involved. Having secured the infant's head between his knees, he should carefully introduce between the lids a wire speculum, of a size and strength of spring proportioned to the small palpebral opening of so young a child.

With a bit of moistened lint the discharge should be gently wiped away, so that the surface of the cornea may be thoroughly explored. If an ulcer exists, it will most commonly be found at the centre. It may occupy the whole area of the pupil, or involve all the cornea except its extreme edge, or the iris may be seen protruding through a complete perforation of the cornea in the form of a brownish nodule. If the whole cornea be destroyed, the iris will be seen bulging forward, covered by a thin glaze of semi-transparent inflammatory deposit. Sometimes it seems as if the posterior elastic lamina had resisted the ulcerative process, and still formed a thin coating to the bulging mass of iris. These are the cases which eventually exhibit *staphyloma*; the deposit upon the iris becoming by degrees thicker and denser, and assuming very much the appearance of opaque, or partially opaque, corneal tissue, over the surface of which, at a later period, arborescent vessels ramify. When the perforating ulcer of the cornea is very large, it not uncommonly happens that the lens escapes through the aperture.

When the purulent ophthalmia is at its height, the lids are red and swollen; but when the cornea has given way, the bright rosy tint of the lids usually gives place to a dull livid colour, the swelling subsides, and the skin becomes flabby. The palpebral conjunctiva, when cleansed from the discharge, appears bright-red and villous.

Treatment.—The nutrition of an infant attacked with purulent ophthalmia is so important—as the means whereby the ulcerative process may be averted, or, if that process have already commenced, reparative material may be supplied for filling up the breach—that, before alluding to local treatment, I would insist upon the importance of the child being suckled, and not brought up by hand. A weakly infant, attacked with severe ulceration of the cornea, and fed with artificial food, has hardly a chance of recovery. Of course the condition of the bowels must be attended to; but care must be taken not to lower the child by unnecessary doses of ‘grey powder’—that panacea for infantile complaints, according to popular belief. Weakly children are often benefited by a few drops—four or five—of Battley’s liquor cinchonæ; given in a tea-spoonful of milk twice a day.

In the local treatment, all depressing and so-called ‘antiphlogistic’ measures are to be carefully avoided. Blistering is perfectly ineffectual towards controlling the discharge, and only weakens and irritates the general system. Abstraction of blood

by leeches is even worse, as depriving the child of that reparative material which is so urgently required for averting or healing ulceration. I know of no application better than a solution of alum—five, eight, or ten grains to the ounce of distilled water—which should be injected between the lids every half-hour. It is well to inject a little warm water before using the alum-lotion, so as to wash away the discharge, and thus allow the alum to come completely into contact with the inflamed conjunctiva.

As the discharge abates, the lotion may be injected less frequently—every hour, or every two hours. Care must be taken not to chill the infant by wetting its clothes during the injecting.

The condition of the cornea must be carefully inspected from day to day. If there be a large ulcer, and the reparative process have set in, the surgeon must not be uneasy on observing that the surrounding portion of the cornea looks cloudy and reddish. This pink tinge is owing to the presence of blood-vessels, advancing towards the ulcer, and conveying to it reparative material. When the ulcer has become completely filled up, these blood-vessels will gradually disappear, and the peripheral portion of the cornea, in which they ramified, will resume its transparency.

Sometimes it is useful to change the local application, and to use a solution of nitrate of silver—two grains to the ounce—dropping a small quantity on the conjunctiva twice or thrice a day. This change of stimulus often acts beneficially, when the puriform discharge has almost ceased, and the ulcer still shows little disposition to heal. As soon as the ulcer begins to fill up rapidly, the alum or nitrate of silver should be used less frequently.

In severe cases of purulent ophthalmia, eversion of the swollen conjunctiva of the lids frequently occurs. This always gives rise to alarm among those who have charge of the child, and is often a cause of anxiety to the surgeon. It is a matter of no real importance; the eversion cannot be controlled by any artificial means, and is sure to cease as soon as the puriform discharge has abated.

'SCROFULOUS OR STRUMOUS OPHTHALMIA.'

(Phlyctænular Ophthalmia)

If by 'ophthalmia' we are to understand an inflammatory affection of the *conjunctiva*, this disease ought not to be termed ophthalmia at all. It is essentially a corneal disease, the *conjunctiva* being only secondarily affected, and I have therefore transferred it to the chapter in which Diseases of the Cornea are described.

CHRONIC OPHTHALMIA.

The acute stage of common catarrhal ophthalmia, if neglected, is apt to subside into a chronic form, characterised by a congested state of the palpebral conjunctiva with an increase in its mucous secretion, an unnatural fulness of the caruncle and semilunar fold, and some degree of redness along the tarsal edges. The patient complains of a sensation like that produced by a small foreign body beneath the lids; luminous bodies appear surrounded by a halo of prismatic colours; the eyes water when exposed to bright light or cold winds; and the lids are gummed together in the morning.

The surgeon, on first seeing such a case, should most carefully explore the edges of the tarsi, to see if any fine eyelashes are growing irregularly, so as to touch and irritate the globe. A single delicate hair, so fine as almost to elude observation, will sometimes suffice to keep up, or even of itself to produce, most of the symptoms I have just described.

Chronic ophthalmia, characterised by the above symptoms, is not always a sequela of acute inflammation. Indeed, it more commonly occurs as a primary disease, in persons whose occupations oblige them to sit for many hours in close and overheated rooms, while engaged on minute objects, especially under artificial light.

Treatment.—When we consider the various classes of persons liable to chronic ophthalmia, it is obviously impossible to lay down rules of treatment which shall be universally applicable. To rectify whatever may be found amiss in the general health, is the first indication. The injurious effects of artificial light chiefly depend upon the abundance of red rays inseparable from every form of it. These may be modified by adapting to the flame of the lamp, or gas-burner, a chimney or shade of trans-

parent glass, slightly tinted with blue. The colour should be so faint as only just to whiten the flame, without imparting to it any decidedly blue tinge.

An immense variety of substances has been used in lotions and drops for the cure of this troublesome affection. Acetate of lead, alum, sulphate of zinc, nitrate of silver, sulphate of copper, tannin, &c., have all found their special admirers. Vinum opii was long a favourite form of drop; while the more homely washes of diluted brandy or vinegar have found favour as domestic remedies. Whatever form may be preferred, care should be taken not to make the solution too strong, and not to use it for too long a time without intermission. The object should be to stimulate the conjunctiva for a short period, and then to give it time to resume its natural functions. Many persons, by the habitual use of strong lotions, keep up the very condition they are seeking to cure. Acetate of lead, or alum, in the proportion of from two to four grains in the ounce of water, are perhaps as useful as any of the more common substances. Bathing the eyes in cold water, night and morning, is in many cases preferable to the use of any medicated lotions. An occasional small blister to the temple is useful when the eyes become suddenly irritable and intolerant of light.

INJURIES OF THE CONJUNCTIVA.

The more serious of these are due to contact with escharotics, heated fluids, or melted metal. Slight lacerations or cuts of the conjunctiva, not involving the sclerotic, require only very simple treatment—water-dressing and closure of the lids. Strong mineral acids, caustic alkalies, and other chemical substances, often produce the most destructive effects upon the conjunctiva and cornea, causing bands of adhesion to form between the lids and the globe, and inflicting upon the cornea such an amount of opacity as wholly to destroy sight. The damage in these cases is so instantaneous that the surgeon has hardly ever the opportunity of neutralising the destructive fluid. If at hand at the moment of the accident he would of course at once inject between the lids such a fluid as would chemically decompose the acid or caustic alkali, and form a neutral salt. Afterwards a little castor-oil or olive-oil may be dropped upon the surface of the globe, and water-dressing applied over the closed lids.

Where melted metal has spurted into the eye, the surgeon

should always evert the upper lid, and explore all the folds of the conjunctiva; for large portions of metal will sometimes lodge beneath the lids in the most singular manner, and remain there quite unsuspected for a long time.

When lime, mortar, sand, or other solid matters, have been thrown against the eye, the upper lid must be everted, and every particle of grit removed in the most careful manner with a small scoop. In such cases it will not do to trust to injections of water only, although they may be useful after the scoop has done its work.

If the surface of the conjunctiva presents an opaque thickened appearance, as if it had been boiled, and the cornea is also of an opaque and pearly hue, the damage to sight is irreparable, and only slight improvement is to be hoped for. In such cases the surgeon must take care not to weaken the patient by bleeding or low diet, for it is by keeping up the patient's reparative power that the life of the corneal fibres is to be sustained, and sloughing averted. Where a portion of the cornea is densely white and opaque, and the rest only slightly cloudy, the latter part may recover much of its natural transparency.

In those cases where the opposed surfaces of the palpebral and ocular conjunctiva have sloughed, it is impossible to prevent the formation of bands of adhesion; but these may be somewhat limited by the frequent use of a probe, to break down the newly-formed granulations.

AFFECTIONS OF THE SUBCONJUNCTIVAL TISSUE.

CEDEMA.

Pressure upon the trunk of the ophthalmic vein or its branches, by obstructing the return of blood from the conjunctiva and subjacent areolar tissue, is liable to produce œdema. In slight cases the œdema is confined to the lower part of the globe, where the distended conjunctiva sometimes overhangs the edge of the lower tarsus: it is only in extreme cases that the œdema extends to the upper part of the globe. In old persons, whose tissues are very lax, I have seen the margin of the cornea overlapped by the œdematous conjunctiva.

Edema and chemosis only differ in degree; the former being a mere exudation of serum in consequence of pressure on the veins leading from the part, while the latter term is restricted to those cases where the conjunctiva and subjacent areolar

tissue are actively inflamed. Abscess in the lids or in the lacrymal sac, tumours, and exostoses in the orbit, periosteal thickening in the neighbourhood of the ophthalmic vein—in short, any direct pressure on this vessel, may give rise to œdema, which cannot therefore be regarded as of itself constituting a disease, or as demanding attention, except as a symptom of something more important which has given rise to it.

ECCHYMOSIS.

Some of the small vessels beneath the conjunctiva may give way in consequence of a violent effort, such as coughing or vomiting, or sometimes without any assignable cause; in children with whooping cough such extravasation often takes place to a great extent. The blood may appear as a small patch on the white of the eye, or it may quite hide the sclerotic, and extend up to the edge of the cornea. The appearance is so peculiar that it can never be mistaken for inflammatory injection. In the latter the individual vessels can always be distinguished, while the extravasation presents the uniform aspect of a thinly spread-out clot.

Subconjunctival ecchymosis not uncommonly causes great alarm to the patient; but, except for its unsightliness, it is quite unimportant. The scraped root of the black bryony (*Tamus communis*) made into a poultice with bread crumbs or linseed meal, applied over the closed lids, and renewed every six hours, will hasten the absorption of blood. If this cannot be worn, frequent sluicing with cold water is the best thing to be done. Nothing, however, will cause the blood to be absorbed until after the lapse of several days.

PINGUECULA.

After the middle period of life, especially in persons who have been much exposed to the weather, or have lived in hot climates, it is very common to see small yellowish elevations on the sclerotic, close to the edge of the cornea, and on the equator of the eyeball. They are sometimes surrounded and traversed by a few fine vessels. When these little elevations attain their full size, they will be observed to have a somewhat triangular form, the base corresponding to the cornea. They have received the name of *pinguecula* from their being supposed to consist of fat; much of their bulk, however, is made up of

fibrous tissue. Pingueculæ are growths so entirely harmless that they would not call for a remark, were it not that they very often give rise to the most serious alarm in the patient, who believes that they will gradually grow over the pupil and obstruct the sight. An explanation of their real nature comprises all that is required on the part of the surgeon.

PTERYGIUM.

This consists in a reddish, fleshy-looking growth extending from the semilunar fold to the cornea, the margin of which it frequently oversteps. It has a triangular shape, its base corresponding to the inner canthus. Slighter forms of this growth are met with, in which, instead of looking like a portion of muscle, the fibres are so thin and delicate as rather to resemble an aponeurosis with a few muscular fibres intermixed. No muscle, however, is found in these growths, which consist of fibrous tissue abundantly intermixed with blood-vessels.

Pterygium, like pinguecula, is found in persons past the middle period of life, and especially among those who have lived in tropical countries. The dust, which is there so abundant, may probably be an exciting cause. A very well-marked case came under my care in a mason and plasterer, who, although always residing in the neighbourhood of London, had of course been much exposed to dust of various kinds. The largest pterygium I ever saw, however, was in a countryman from Essex, in whom the apex of the growth, instead of stopping short of the area of the pupil, as is commonly the case, spread so far across the cornea as almost to hide the whole of the pupil. In this case I removed the growth; and whenever the apex extends so far as to occupy a large portion of the cornea, the deformity it produces may demand an operation. The lids being held asunder with a spring speculum, the lax portion covering the sclerotic is to be nipped up in a forceps, and cut across with a fine scalpel midway between the edge of the cornea and the semilunar fold. The portion extending towards the cornea may then be dissected off the sclerotic, great care being taken when that part is removed which adheres to the cornea. It is well not to remove the inner third of the pterygium, as otherwise the semilunar fold and caruncle are apt to retract, which afterwards gives an unpleasant prominence to the eyeball.

No other local treatment than removal with the knife or scissors is of any avail in getting rid of a pterygium. Stimulating lotions and drops only excite it to grow; and the varieties of pterygium described by authors, under the names of *sarcomatous*, *fungous*, *cancerous*, and *malignant*, were probably nothing more than common forms of the growth, irritated and teased by escharotics.

FATTY TUMOURS.

Fatty deposits to any large extent beneath the conjunctiva are uncommon. The few cases I have seen occurred in children, and the tumours all occupied the same position, namely, the line of reflection of the conjunctiva from the lower lid on to the globe. They extended from near the lower edge of the cornea to the outer canthus, were of an elongated form, almost resembling a haricot bean, and were partly concealed by the lower lid. On dividing the conjunctiva and the proper fibrous envelope, the fatty mass was easily turned out.

CYSTICERCUS TELÆ CELLULOSÆ.

This parasite is occasionally found in the subconjunctival cellular tissue, but it appears to be of very rare occurrence. I have seen but two instances, both in females, one patient being six, the other eighteen years old. The appearance was that of a rounded body, about as large as a pea, midway between the inner canthus and the cornea. There was a good deal of vascularity in the conjunctiva covering and surrounding it. In the first case a little watery bladder, rather larger than a pin's head, had been observed about eighteen months before the patient was brought to me. In the second case, no account could be given as to the first appearance of the growth. On the conjunctiva being divided, the cysticercus slipped out, and was at once recognised under the microscope. Sichel, in his *Iconographie*, gives a very good figure of a cysticercus in the position I have described (pl. lxxii. fig. 2), and also of one developed beneath the plica semilunaris (fig. 1). In other figures of the same plate, the animal is shown both in its natural size and magnified.*

* Græfe mentions five cases of subconjunctival cysticercus as having occurred in his *clinique*, during a period of thirteen years. *Archiv für Ophthalmologie*, xii. 2, 174.

At the time I saw these two cases the connection between the development of *tænia* in the intestines, and of *cysticercus* in other parts of the body, had not been pointed out; nor was it suspected that two creatures so dissimilar were really the same animal under different forms of development.*

STAINS FROM NITRATE OF SILVER.

Before quitting the subject of affections of the conjunctiva and subjacent tissue, I may say a few words respecting the serious disfigurement which results from the prolonged use of nitrate of silver in solution. No surgeon who understands the real action of this substance—its invaluable efficacy in catarrhal ophthalmia, and its inutility or injurious effects in affections of the cornea—would be likely to employ it in such a manner as to produce permanent staining of the tissues of the eye; for in no case is its prolonged use of any service; the good it does, it does in a few days. Patients, however, have such unbounded faith in the efficacy of eye-drops and eye-waters, that they will frequently continue the use of them for months and even years.

One of the worst cases of staining with nitrate of silver I ever saw came under my notice only a short time ago. A woman, with incurable opacity at the centre of the cornea—the cicatrix of an ulcer, in fact—had been ordered to use drops of nitrate of silver. This she did for some months, under a surgeon's advice. She then went to another part of the country, but still continued the use of the drops, putting in, as she assured me, 'two drops every day for *ten years*.' The whole of her sclerotic was of a dirty sepia tint, most marked towards the lower part of the globe. The cornea itself slightly partook of the same tint, and the conjunctiva of the lower lid, thickened and vascular, looked as if a brush dipped in liquid sepia had been passed over it, the dull red colour of the conjunctiva being only seen where the membrane had formed a fold.

In another case, where this discoloration existed in a less marked degree than in the case just mentioned, I tried the effect of a solution of cyanide of potassium. The patient was an intelligent man, and could thoroughly understand the principle of the treatment, which was to keep the whole surface of stained tissue for a lengthened period in contact with the fluid. This was effected by the help of an 'eye-glass,' and I told the patient to draw down the lower lid, and to fix it against the cheek-bone with the rim of the glass, before throwing his head back. After several months but little benefit had resulted, and I then tried a solution of hyposulphite of soda, beginning with a

* See Küchenmeister, *On Animal and Vegetable Parasites of the Human Body*; and Von Siebold, *On Tape and Cystic Worms*; published by the Sydenham Society, 1857. See also the essay on PARASITES in the Appendix.

strength of ten grains to the ounce of water—as the effect of the substance was unknown to me—and gradually increasing it up to a drachm to the ounce. The change effected was very slow, but when I last saw the patient the stain was barely traceable on close inspection.

CHAPTER IV.

DISEASES OF THE CORNEA.

THOROUGHLY to appreciate the slight changes in the cornea which are capable of affecting the sight, the surgeon should clearly understand that the normal condition of the part consists in absolute transparency of its whole thickness, and perfect polish of its surface; every deviation from these conditions is an evidence of some morbid action.

When a healthy eye is examined near a window, the image of the window-frame ought to be depicted on the surface of the cornea with the most perfect sharpness and clearness of detail. A slight amount of inflammation, just enough to cause some thickening of the epithelium, destroys the brilliant polish, and causes the image of the window to appear blurred and dull, and the lines of the sash-bars crooked and wavy. This appearance is often important as giving notice that inflammation of other tissues of the eye may be going on; as in the early stage of Glaucoma, where this dull condition of the epithelium is always to be seen.

CONICAL CORNEA.

(*Hyperkeratosis*—the tissue of the cornea being erroneously supposed to be in excess; *Staphyloma corneæ pellucidum*; *Keratoconus*.)

This curious and rare* malformation consists in a change in the form of the cornea from a segment of a sphere to a cone, the transparency of the part remaining unaltered. There seems to be no peculiar constitution which predisposes to the affection. It is met with in both sexes; in persons apparently of good general health, as well as in the delicate and sickly: nor have I ever observed that any special employment, or mode of life, could be traced as the exciting cause.

* That the disease is very rare may be seen by reference to a table which I contributed to the *London Journal of Medicine* (vol. ii. 1850), showing the number of cases of conical cornea occurring among the patients annually received at the Moorfields Hospital from 1819 to 1849.

The aspect of a patient with conical cornea is so peculiar, that when once seen, the affection can never afterwards be overlooked. The eye, viewed in front, has a brilliant and sparkling appearance, as if a tear were hanging just in front of the pupil. When seen in profile, the conical shape of the cornea is at once recognised. The position of the iris is unchanged, and its movements are perfectly natural; nor is any other tissue, except the cornea, observed to be affected. In saying that a conical cornea is perfectly transparent, I should modify the remark as far as concerns the extreme apex of the cone, which sometimes, when viewed closely, presents an appearance of slight opacity. In some cases this seems due to an actual haziness in the tissue itself; but the appearance is frequently caused by mere refraction of the rays of light. There seems no good reason for attributing this slight cloudiness of the apex of the cone to the friction of the lids.

The apex of the cone almost always corresponds to the centre of the cornea; but in very rare cases it has been observed to deviate from this position. The deformity usually begins when the patient is between twenty and thirty. At first he grows short-sighted, but as the change goes on, a remarkable refraction of the rays of light is produced; the flame of a candle appears surrounded with a halo, then it seems to be divided into a multitude of diverging rays, and sometimes, instead of a single flame, several flames are seen, arranged in a circle. When the last stage of conical deformity has been reached, the patient cannot read, even at the shortest focus.

In the few cases in which conical corneæ have been dissected, the apex of the cone has been found very much thinned. The mode in which the disease originates is at present quite unexplained; and in proportion to the obscurity which attends its cause have arisen the most varied suggestions for its treatment. Repeated evacuations of the aqueous humour, the same operation followed by pressure on the cornea, removal of the lens by extraction or solution, these, and perhaps other forms of operation, were formerly tried, but without benefit.

About thirty-three years ago, Tyrrell tried the effect of displacing the pupil towards the corneal margin. With the blunt hook he invented, he drew out a small piece of the iris, and cut it off, leaving a portion of the cut tissue entangled in the wound. His object was to bring the pupil opposite the flatter portion of the cone; but the result did not answer his expectations. A

better form of this operation has been lately devised, whereby the pupil is transformed into a long narrow chink, reaching quite across the cornea. A small wound is made close to the corneal margin, a blunt hook or fine forceps is introduced, and the pupillary portion of the iris, having been drawn out, is tied with a fine ligature. (See *Iridesis*.)

At a later period, when the corneal wound is healed, and the aqueous humour retained, a similar operation is performed on the opposite side of the cornea. This operation, should, I think, be limited to those extreme cases of conical deformity which cannot be palliated by any optical contrivance.

Slight cases are sometimes benefited by deeply concave glasses; but in the complete stage of the disease, the sight is little, if at all, aided by glasses of any kind. A small aperture, like a pin-hole, in a metallic plate, held close to the eye, will in most cases of confirmed conical deformity enable a patient to read at a focus of five or six inches, who previously had been unable to discern a letter. If, instead of a hole, a slit about three-quarters of an inch long and the thirtieth of an inch wide, be made in a metallic plate fixed into a spectacle-frame, a considerable extent of lateral vision is obtained, without any necessity for moving the head in the way which is necessary when objects are viewed merely through a small circular aperture. It was the benefit derived from this slit in a metallic diaphragm which suggested the operation of *Iridesis* just described.

Quite ineffectual have been the lotions, the drops, the escharotics, which have been used in every possible variety. Their employment was justified by the expectation that local astringents might induce contraction in the tissue of the cornea; and if they failed to do this, they at least, if carefully used, could do no harm to the patient's system. But a plan of treatment was devised some years ago, which appears to be so utterly irrational, and is so fraught with mischief to the digestion and general health of the patient, that I cannot quit the present subject without a few words of warning against it. The plan consists in giving the patient a grain of tartar-emetic, or a scruple of sulphate of zinc, together with two, three, or four drachms of sulphate of magnesia, every day for a year, or even longer. How any patients could be found willing to submit to such treatment is perfectly astonishing. I have, however, seen several who had done so. One poor woman had punctually followed out this 'emeto-purgative plan' for one whole year,

and for nine years longer had taken the mixture at intervals. She was a martyr to dyspepsia, as might well be imagined, and utterly broken down in general health. Her corneæ remained conical.

ARCUS SENILIS.

This term is by no means well chosen, for the change in the cornea which it implies commences long before old age can be said to have arrived, and by the time the patient has reached the age of sixty or seventy, the arc has usually been converted into a complete circle. Several years ago, Canton described the appearance as being due to a fatty degeneration of the peripheral portion of the cornea; and the term ‘arcus adiposus’ would therefore be well applied to its early stage, and ‘annulus adiposus’ to that condition in which the white ring completely encircles the cornea. In many persons past forty years of age, in some even at a much earlier period, an opaque whitish crescent may be observed skirting the margin of the cornea, either at its upper or lower part. This opaque crescent is the commencement of the so-called ‘arcus senilis;’ and on close inspection it will be seen that the opacity is not an extension of the white tissue of the sclerotic into that of the cornea, but that a narrow interval of partially clear cornea always intervenes between the two opaque structures. In some old persons, the circle assumes a chalky whiteness, and presents a very striking appearance.

‘Arcus senilis’ is considered by some observers to indicate the co-existence of fatty degeneration of the heart. As far as the eye itself is concerned, the change can be considered as of very little importance. It certainly does not, as has been asserted, in any way contra-indicate the operation of cataract by extraction; for I have many times carried my section through a strongly-marked ‘arcus senilis,’ and the wound has become quickly and firmly united.

INFLAMMATION OF THE CORNEA.

(*Keratitis; Corneitis*. The former of these terms—from *κερατις*, horny—is undoubtedly preferable to *Corneitis*, which is neither Greek nor Latin.)

The healthy cornea, as I have already observed, is of the most perfect transparency, and its surface smooth and brilliant in the highest degree. These qualities are lost as soon as the part becomes inflamed; a general haziness overspreads the whole structure, and the surface looks like a steamy glass.

If the inflammation be acute, a crescentic plexus of vessels will be seen passing from the edge of the cornea for some little distance—a line or more—into its substance. These vessels are so fine, and so closely set together, that they produce the appearance of a small patch of blood smeared upon the surface of the cornea. With a lens of an inch focus the individual vessels composing the plexus may be identified. This characteristic plexus sometimes involves a third or even a half of the corneal circumference.

A zone of pink vessels is always seen in the sclerotic adjacent to the cornea, whenever any form of active keratitis is present; this *sclerotic zone* also exists whenever the iris is inflamed. It is therefore always to be regarded as an important sign. As acute keratitis advances, some portion of the hazy cornea may become more decidedly opaque, and of a pale yellow tint; this shows that softening is going on, which may lead to actual giving way of the part. Intolerance of light and abundant secretion of tears accompany keratitis. The larger venous trunks of the conjunctiva become full and distended, but there is an absence of that fine vascular network in the conjunctiva which characterises ophthalmia.

One eye is usually attacked at a time, but the other may sooner or later become involved, and it very often happens that the second eye becomes inflamed just as the first is recovering.

Children and young persons are the most frequent subjects of keratitis, and the disease is rare after the age of twenty. The subjects of it are usually of a weakly, irritable constitution, often pale and anæmic; in some cases presenting the swollen cervical glands and other marks of scrofula.

The prognosis is favourable in proportion as the patient is young, and is seen at an early stage of the disease.

The mischievous and too common practice of keeping such patients confined to darkened rooms often induces a morbid irritability of the nervous system, and an intolerance of light, which is still farther aggravated by the irritating drops so unsparingly applied to eyes affected with corneal inflammation.

Under judicious management a case of keratitis occurring in a child may sometimes pass off without leaving a trace of opacity. But when the disease occurs after puberty, and is severe and obstinate, perfect transparency is hardly ever restored, and the cornea remains ever afterwards rather more convex than natural, and very faintly mottled with opacities and partially transparent

interstices. These opacities resulting from long-continued keratitis, without ulceration, require to be thoroughly understood; for the surgeon who has not made himself familiar with their appearance will be sure to overrate the patient's powers of sight. It seems as if long-continued keratitis in patients who have passed childhood were attended with some peculiar change in the fibres of the cornea, whereby those portions which present only the slightest traces of opacity become, from irregular refraction of the rays of light, unable to transmit a clear and well-defined image of objects.

Treatment.—I have already alluded to the constitutional peculiarities commonly met with in patients who are the subjects of keratitis. They are in every way unfitted to endure the 'anti-phlogistic' measures recommended in so many works on eye-diseases. The diet should be nutritious and abundant, but not given in such quantities as to oppress the stomach and impair digestion. Very young children are almost always better without beer or wine. The former should be given to older children once a-day if they have been accustomed to it; but wine can only be required by children suffering from extreme debility; in ordinary cases it hurries the circulation, and increases the general irritability of the nervous system. Of course the condition of the bowels is to be carefully attended to; and where the state of the biliary and other secretions may demand the use of mercury, an occasional dose of calomel—one or two grains, with or without a proportionate quantity of rhubarb—is to be given; but anything like a mercurial course is to be avoided. Iron is, of all substances, the most beneficial in cases of genuine keratitis, but it frequently fails in consequence of being given in too large doses, and for too long a time without any pause. The *tinctura ferri sesquichloridi* is the form I usually prefer, giving it invariably directly after food, or even during a meal, and in doses varying, according to age, from five to twelve drops twice a day. The *syrupus ferri iodidi* is sometimes useful. Occasionally, when the patient is feeble, ill-nourished, or of phthisical tendency, cod-liver oil may be given as well as the iron, or even, for a time, instead of it.

Counter-irritation, by means of small blisters to the temples, is often valuable in combating the intolerance of light; and tincture of iodine, applied to the skin of the lids, also conduces to the same end, and is preferable to blisters in patients of extreme delicacy of constitution.

Inflammation of the cornea is essentially a tedious disease, and the surgeon must often wait patiently for weeks, and even months, before the transparency of the part is restored. Hence it will be seen how necessary it is to give the tonic medicines in small doses, such as the patient can go on with for a considerable period, instead of attempting to conquer the disease at once by giving large doses, which cannot be persevered in without derangement of the stomach and liver.

Warm fomentations, night and morning, or steaming the eyes over hot water, will usually be found to allay their irritability; but all stimulating lotions and drops do harm.

How any one who has seen much ophthalmic practice can recommend the application of solid nitrate of silver to the conjunctiva in cases of keratitis, I cannot comprehend. The same substance in solution, and the sulphates of copper and zinc, are also frequently employed, and sometimes the ointments of the nitrate and nitrico-oxide of mercury are added, as if on purpose to increase the irritation already existing.

‘SCROFULOUS OR STRUMOUS OPHTHALMIA’ (SO CALLED).

At page 50 I have observed that the well-known disease commonly called Scrofulous Ophthalmia (*Phlyctænular Ophthalmia* of Mackenzie) derives all its importance from the fact that the cornea is implicated; and I therefore proposed to separate the disease from the group of conjunctival inflammations, to which alone the term ‘Ophthalmia’ strictly belongs, and to treat of it under the head of Inflammation of the Cornea.

It specially attacks children, but certainly is not always confined to those of scrofulous constitution; at least it is met with where there is no evidence of tubercular disease. The most striking symptom is extreme intolerance of light (*photophobia*), and general irritability of the eyes and of the whole system. The local affection of the cornea shows itself either in a small whitish elevation (*phlyctænula*), or an ulcer. In either case a long plexus of vessels runs from the corneal margin to the morbid spot. This long plexus or lash of vessels is quite diagnostic of the disease. It is sometimes seen when the rest of the cornea is almost clear, but more commonly there are several phlyctænulæ or ulcers, and the whole of the cornea is more or less hazy. The intolerance of light I have mentioned, as being characteristic of the disease, causes violent spasm of

the orbicularis palpebrarum, which is increased when the surgeon makes any attempt to examine the eyes. The intolerance is often much increased by the too common but most injudicious practice of keeping the patients in dark rooms. After many hours of darkness, the sudden admission of light is of course extremely painful. If the intolerance is very great, or the child too young to be open to persuasion, the examination must be made by means of the wire speculum.

The pain caused by exposure to light is often out of all proportion to the extent of corneal disease. In some extreme cases the surgeon is surprised to find merely a small whitish elevation (*phlyctænula*), or an ulcer the size of a pin's head, with the characteristic streak of vessels reaching to it from the edge of an almost clear cornea.

In true cases of this form of keratitis there is hardly any increase in the mucous secretion from the conjunctiva, but the flow of tears is profuse, and they gush out each time the lids are separated. There is a more or less marked zone of vessels in the sclerotic immediately around the cornea, but no general redness of the globe, the chief increase of vascularity being due to distension of the larger veins of the conjunctiva. The lids are often raw and excoriated at the edges, and the outer commissure is inclined to crack and bleed. Swollen and fissured lips and alæ nasi, excoriations and cracks behind the ears, eczema on various parts of the face, and eruptions on the scalp, are occasionally found to accompany this disease of the eyes in the more severe and long-continued cases.

Treatment.—Both the skill and patience of the surgeon are often severely tried by these cases, especially if they have been neglected, or treated injudiciously, before coming into his hands. Long-continued doses of mercury, seclusion in dark rooms involving the loss of air and exercise, and too much of food and stimulants, are the common sources of unsucccess as regards general management, whilst the local application is too often just that which is most hurtful—namely, nitrate of silver.

Under the head of Catarrhal Ophthalmia I have spoken of the valuable properties of this substance in solution, in cases where the inflammation is limited to the conjunctiva; and I have also mentioned how beneficially the application of the solid nitrate acts in arresting the rapid ulceration of the cornea in purulent or gonorrhœal ophthalmia. But the too common practice of dropping-in a solution of the nitrate in cases where the cornea

is attacked either with phlyctænulæ or ulcers, is most mischievous, and often prevents the cure of a case which in other respects may have been judiciously treated.

I have said that children attacked with this disease should by no means be shut up in dark rooms. Light is as essential to the health of animals as of plants, and all inconvenience from bright light can be averted by the use of a large shade, or in elder children a pair of tinted spectacles. Out of doors a blue or green veil may be added. Moderate exercise in the open air should be taken whenever the weather is mild and dry, and sea-air is generally the most desirable, provided the place selected be not too bleak and windy. I have alluded to the ill effects of too much food and stimulants; but in doing so, I would not be supposed to recommend low diet: on the contrary, there should be an abundance of nutritious, easily-digested food. My remark was directed against that pernicious practice of stuffing young children with more animal food than the stomach can properly digest, and over-exciting their irritable circulation with wine and beer, as if their disease could, as it were, be taken by storm and extinguished by mere eating and drinking. Of course there are exceptional instances of very weakly children who require a small quantity of wine; but, as a rule, beer is preferable at an early age, and to those unaccustomed to stimulants pure milk will often be found of far more service.

With respect to drugs, I know of nothing so useful as iron in cases of keratitis, whether attended with phlyctænulæ or ulcers. It may be given alone, or in combination with quinine, according to circumstances. The reason why iron is so often ineffectually prescribed in this disease and in many others, appears to me to be, that it is given in too large doses and at wrong times. The form I prefer is the *tinctura ferri sesquichloridi*, in doses of 5, 10, or 12 drops, twice or thrice a day, to children ranging from five to fifteen years of age. It is best taken in water, and always immediately after a meal. Weakly children may at the same time take with advantage cod-liver oil. Every fortnight or so the iron may be discontinued for a couple of days, and if the bowels have become confined, or the liver appear to be deranged, a mild aperient may then be taken, with half a grain, a grain, or two grains of calomel, according to age and constitution.

Of local applications none are so generally employed as blisters; and no doubt, when used judiciously, they are very

serviceable in subduing that intolerance of light which is one of the most distressing features of the disease. But here again a great mistake is frequently made in applying blisters of too large a size, and without sufficiently discriminating between those constitutions that will and those that will not bear them.

In feeble anæmic subjects a blister, even of small size, will often produce considerable depression; and in very young children with irritable skin, will bring out a troublesome eczematous eruption. The best effect is produced by applying blisters the size of a shilling or a florin to the temple, allowing the part to heal quickly, and repeating the blister when the cuticle is reproduced at the end of a week or ten days. A more rapid form of counter-irritation is that produced by undiluted tincture of iodine, painted on the skin of the upper lid. This may be repeated as often as the skin recovers its natural condition.

The lids may be bathed night and morning with warm water, or the steam of hot water may be allowed to play against them, which avoids the mechanical irritation of rags or sponges.

Spermaceti-ointment, or fresh olive-oil, may be smeared along the eyelashes at bedtime. Lotions of acetate of lead, or alum, two or three grains to the ounce of water, are sometimes useful where there is on the cornea merely a small opaque patch (phlyctæna), with the characteristic lash of vessels running to it; but whenever an ulcer exists lead-lotions are improper, as the carbonate of lead, which is precipitated from them, is liable to form an insoluble white deposit in the cicatrix.

Leeches always do harm in cases of true keratitis with ulceration of the cornea. The barbarous proceeding termed 'scarification of the lids,' is, I hope, so nearly obsolete as not to require notice.

To get rid of the plexus of vessels running from the edge of the cornea to the phlyctænula or ulcer on its surface, it has been gravely proposed that the vessels should be cut across with a lancet. This is, indeed, beginning at the wrong end. '*Ubi stimulus, ibi affluxus*;' so long as an irritable patch of deposit, or an ulcer exists, so long will an irregular supply of blood be sent thither. Heal the ulcer, or get rid of the irritability of the cornea, by constitutional means, and the plexus of vessels will vanish.

The opacities remaining after a long-continued attack of scrofulous ophthalmia are, to a certain extent, permanent; that

is to say, if they result from the healing of ulcers. But if the ulcer be superficial and the child very young, it is surprising to see how faint a trace remains in after-life, to mark the site of the cicatrix.

SYPHILITIC KERATITIS.

It is to the careful observations of Hutchinson, that we owe the true knowledge of this remarkable form of corneal inflammation. Not that he detected a disease which had never been seen before; on the contrary, it was in patients who might have been selected as affording typical specimens of 'strumous ophthalmia' that he first declared the morbid appearances to be due, not to scrofula, but to inherited syphilis. He named the disease 'chronic interstitial keratitis;' but I think we may fairly substitute the shorter term *sypilitic*. No confusion can arise from thus naming the disease, because there is no special form of corneal inflammation connected with acquired syphilis, the chronic interstitial form being met with exclusively as a sequela of an *inherited* taint.

The subjects of this form of keratitis are children and young persons from five to eighteen years of age, and most frequently it is an eldest child that comes under observation. The disease begins at the centre of one cornea, in the form of a diffused haziness, like that of ground glass. Very soon whitish dots appear in the midst of the haze, not on the surface, but in the very substance of the cornea. These dots generally run together, and thus increase the amount of central opacity. At first there is but little attendant vascularity of the sclerotic and conjunctiva, but as the central opacity becomes more marked, these tissues become reddened, and a fine plexus of vessels spreads on the cornea itself, and gradually pervades the opaque portion, affecting the upper and central part of the cornea in preference to its lower half. Throughout the whole course of the disease there is no tendency to ulceration.

Usually within about two months—or it may be much earlier—the other cornea begins to be affected, the disease commencing, as in the eye first attacked, by a central haziness.

The vascularity of the cornea, when the disease is at its height, is wholly unlike that which attends granular lids, and other chronic forms of keratitis. In the latter the vessels are large and superficial, whereas in the disease now under con-

sideration they penetrate the cornea so deeply, and are so fine and closely set together, that the effect produced is that of a tissue infiltrated with blood.

‘In almost all cases the subjects of this keratitis,’ says Hutchinson, ‘present a very peculiar physiognomy, of which the most striking signs are, a coarse flabby skin, pits and scars on the face and forehead, cicatrices of old fissures at the angles of the mouth, sunken bridge to the nose, and a set of permanent teeth peculiar for their smallness, bad colour, and vertically notched edges.’ He adds : ‘As diagnostic of hereditary syphilis, various peculiarities are often presented by the other teeth, especially the canines, but the upper central incisors are the *test-teeth*. When first cut, these teeth are usually short, and the cutting edge is narrow from side to side, and very thin. After a while a crescentic portion from their edge breaks away, leaving a broad, shallow, vertical notch, which is permanent for some years, but between twenty and thirty usually becomes obliterated by the premature wearing down of the tooth.’ ‘I have not met with a single example of well-characterised interstitial keratitis in which the teeth were of normal size and shape.’

More extensive experience has caused Mr. Hutchinson to modify this last remark, and he mentions several exceptional cases in which all the appearances of syphilitic keratitis were present, in association with well-formed teeth.

One very remarkable instance of keratitis—I think the severest I ever saw—occurred in my own practice, in a young lady whose teeth were quite remarkable for soundness and symmetry ; but in her the peculiar physiognomy was well marked, and her history completely confirmed the fact of her inherited syphilis. I have also seen some striking cases, in which patients with well-formed features, and clear and ruddy complexions, had strongly-marked syphilitic keratitis ; but their teeth were more or less affected. We therefore may meet with severe syphilitic keratitis in patients with healthy physiognomy and deformed teeth ; or—still more rarely—in those with faultless teeth and the syphilitic cast of features ; but to find the true form of keratitis in connection with both good teeth and good complexion also, is, I think, next to impossible.

I frequently notice that medical men who have not read Hutchinson’s careful descriptions, but have only heard of ‘notched teeth,’ expect to find serrated edges, such as one so

often sees in newly-cut healthy incisors. 'Serrated,' however, implies a series of notches. A single notch is that to which Hutchinson first drew attention; and the following figure, copied from his work, will at once show the reader what he is to look for.

FIG. 144.



In adults the notch often becomes worn away, but even then the tooth retains a characteristic shape. I liken it to that of a screw-driver, being wide at the base, where it joins the gum, and narrow at its cutting edge; while its lateral edges are thick and rounded. The lower incisors never lose their peculiar form, which is more or less cylindrical, and they are commonly wider apart than healthy teeth.

It must be always borne in mind that these syphilitic peculiarities in the teeth are only met with in the permanent set. The first set are not notched, but they are usually stunted and prone to premature decay.

Treatment.—A combined specific and tonic plan is advocated by Hutchinson, as being more efficacious than one exclusively tonic, and he advises the cautious use of mercurials and iodides. He prefers to administer the mercury by rubbing-in the milder ointment, always avoiding ptyalism, and gives internally iodide of potassium and iodide of iron.

I believe iron, under some form or other, to be the one drug needful. It should be given in small doses, because the cure is necessarily very slow, and the medicine must therefore be continued for many months. An occasional small dose of calomel—a grain or so once a fortnight—is requisite to prevent the iron deranging the liver, but I do not think 'a mercurial course,' as it is termed, either necessary or beneficial. The forms of iron I prefer are the *tinctura ferri sesquichloridi*, and *syrup. ferri iodidi*. For a young child six or seven years of age, eight or ten drops of the tincture, given once a day immediately after a meal, will be a full dose; each fortnight it may be left off for a day or two, and a grain of calomel given. Even for patients sixteen or eighteen years old, the dose of the tincture need never exceed fifteen or twenty drops.

Good diet, pure air, and all things calculated to improve the

condition of the blood and tissues, are of the utmost importance in treating the cachectic subjects of inherited syphilis. The surgeon must ever bear in mind that the severer forms of syphilitic keratitis require a very long time for their cure. A bad case will require a year or even longer, and the friends of the patient ought at the very first to clearly understand this. A rapid cure is quite impossible. If only the vascularity of the cornea disappears, and from month to month the part becomes less opaque, the very worst case may terminate satisfactorily. It is, however, unreasonable to expect that in very severe cases absolute transparency of the cornea will ever be attained.

A very chronic kind of iritis commonly accompanies the severer forms of syphilitic keratitis, and the consequent deposits in the pupil, or around its margin, are first detected when the cornea is recovering its transparency.

KERATITIS WITH SUPPURATION.

In simple inflammation of the cornea, the opacity, however dense it may be, consists of inflammatory exudation among the fibres of the part, without any destruction of the fibres themselves. Under certain conditions of the patient's system, however, the inflammation may run a very acute and rapid course, and within a few days terminate in suppuration or ulceration.

When suppuration takes place in the substance of the cornea, it is most frequently at the centre, or a little below that spot, that the pus collects. Its presence is usually manifested by a small yellowish patch in the midst of the general haziness. In very severe cases this yellow patch may rapidly spread, until the whole cornea assumes one uniform creamy tint, entirely hiding every trace of iris; the cornea then softens, and gives way at some part, the iris prolapses, and vision is eventually lost.

These are extreme cases: a more ordinary form of suppuration is that in which the pus gradually infiltrates the lower third, or even the lower half, of the cornea, and at last makes its way through the posterior elastic lamina, and then sinks down to the bottom of the anterior chamber, where it forms what is termed *hypopyon*.*

* This collection of pus at the bottom of the anterior chamber is by some authors termed *onyx*; others use the latter word—now almost obsolete—to signify an abscess in the substance of the cornea.

The giving way of the posterior elastic lamina of the cornea is sometimes speedily followed by that of the anterior lamina, and in that case a perforation is established, through which a prolapsus of the iris takes place. This perforation of the cornea is followed by immediate relief of the severe pain which had existed as long as the pus was pent up among the fibres of the cornea, or in the anterior chamber. This pain is often severe to a degree quite incredible to those who have never witnessed such cases, assuming the form of neuralgia, and wholly preventing sleep.

Treatment.—In general surgery we are so accustomed, whenever an abscess forms, to regard its evacuation as the very first indication for treatment, that I may be expected to mention a puncture for giving exit to the pus, as the most important step in treating a case of suppuration in the cornea. But although it is common to speak of *abscess* in this part, the matter is not contained in a distinct cavity, but is infiltrated among the corneal fibres, so that if an incision be made, the pus does not flow out. The cornea, too, differs from every other superficial tissue of the body, in being transparent; and we should avoid inflicting any unnecessary wound, even to the smallest extent, upon a structure, the transparency of which is essential to sight.

The general tonic plan of treatment I have sketched out as suitable to cases of common keratitis will be applicable, with certain modifications, to keratitis with suppuration. We must take care not to reduce the patient's vital powers; for if we do, not only will the softening of the corneal tissue be likely to spread, but if perforation of the cornea takes place, there will be a deficiency of reparative material to fill up the breach, and a large prolapsus iridis, with consequent distortion or obliteration of the pupillary opening, will be the result.

In the very early stage of suppuration, when a small yellowish patch in the midst of the hazy cornea is all that is seen to mark the beginning of suppuration, blistering to the temple sometimes aids in checking the formation of pus; but when a considerable portion of the cornea has become infiltrated, and severe neuralgia sets in, blistering only aggravates the pain. Narcotics must then be given; to children, a few drops of tincture of hyoscyamus at bedtime; to adults, a fuller dose—3ss. or ʒj. In very severe cases of neuralgia in the fifth nerve, hyoscyamus will be found unavailing, and morphia must be resorted to, especially if the patient be accustomed to

the use of opium. Sometimes a piece of lint steeped in chloroform liniment, and laid upon the temple and forehead, over the region of the lacrymal and supraorbital branches of the fifth nerve, is of great service in lulling the pain.

If the infiltration and softening of the cornea go on to perforation, the aqueous humour at once drains away, and then the neuralgia usually ceases, or is mitigated in a remarkable degree. If the pain ceases, so as to allow the patient to obtain sleep without the aid of narcotics, they ought, as soon as possible, to be laid aside; for they almost invariably take away appetite, and the patient is now in need of good nourishment to hasten the repair of the breach in the cornea.

Bark and ammonia, or quinine, may be required at this stage of the disease; but a carefully-regulated nutritious diet, with a moderate amount of stimulants, must be the chief sources of the reparative process.

As respects local treatment; protection from light, and occasional fomentation with warm water or poppy-decoction, comprise all that is necessary during the earlier stage. When, however, the cornea has given way, the eyelids must be kept constantly closed, either by the application of a strip or two of plaster, or by means of a light pad of cotton-wool, arranged around the eyeball, and kept in its place by a bandage. The eye should only be opened occasionally by the surgeon, to ascertain the progress of repair. In some cases it is useful to abstain from examining the eye for four-and-twenty or eight-and-forty hours.

When prolapsus iridis has occurred, this occlusion of the eye is especially useful, as, by keeping the parts at rest, an opportunity is afforded for the adhesion of the protruded iris to the edges of the aperture in the cornea. As soon as this adhesion has taken place, no more iris can escape, and the prolapsed portion gradually shrinks, and flattens down to the level of the cicatrix. When, from want of vigour in the patient, the adhesive process is sluggish, it is sometimes useful lightly to touch the prolapsus with a point of nitrate of silver.

To attempt to return a portion of iris which has prolapsed through a loss of substance in the cornea, is utterly futile; for it will protrude again and again, so long as there exists an aperture for it to escape through.

Disease of the fifth nerve, caused either by pressure on its trunk, as it is emerging by the side of the pons Varolii, or by

primary degeneration in the tissue of the nerve itself, will give rise to a form of keratitis with suppuration very similar to that described in the preceding pages. In the cases of disease of the fifth nerve which I have seen, this affection of the cornea has not come on during the neuralgic stage, but at a later period, when, in consequence of partial or total destruction of the trunk of the nerve, there has been anæsthesia of the parts supplied by the ophthalmic division. In three or four cases which I have watched, the whole cornea was not destroyed; but after perforation had occurred, the process of softening ceased, and reparation so far took place that eventually there remained only an opaque cicatrix in the cornea, to which a portion of the iris adhered.*

‘EXANTHEMATOUS OPHTHALMIA’ (SO CALLED).

(*Post-febrile ulceration of the cornea; Ophthalmia morbillosa; Ophthalmia scarlatinosa; Ophthalmia variolosa; Ophthalmia erysipelatosa.*)

The various forms of ophthalmia accompanying the exanthemata have been described by some authors with considerable minuteness; but if we restrict the term ophthalmia to signify an inflammation of the conjunctiva, it is perhaps in measles only that any very marked ophthalmia can be said to occur. Taking place, as it does, at the onset of the attack, it is one of the most marked symptoms of the disease, but demands no special treatment. The really important affection connected with measles, is the *ulceration of the cornea*, which results from the general debility produced by the disease. This ulceration is commonly attributable to a neglect of tonic treatment after the inflammatory symptoms have passed away. Iron and quinine, alone or in combination, cod-liver oil, the various influences of fresh air and nutritious diet, are all to be put in requisition to avert or to heal these ulcerations.

Scarlatina, on account of the greater exhaustion of the powers of life which it induces, is still more likely than measles to be

* In a paper published in the eighteenth volume of the *Medico-Chirurgical Transactions*, 1845, I drew attention to the fact, that anæsthesia of the fifth nerve was far more frequent on the *left* than on the right side. In 1857 I forwarded to the editors of the French translation of Mackenzie's *Treatise* (vol. ii. p. 763) a note containing all the literary references to cases of anæsthesia of the fifth nerve which I had collected up to that time. The result of the analysis of fifty-one cases is as follows: in five patients the fifth nerve was affected on both sides; in thirteen the right nerve only was affected; while thirty-three patients had anæsthesia of the *left* nerve.

followed by ulcers of the cornea. In some extreme cases of this frightful disease, the corneæ lose their vitality, and entirely slough away. The same system of tonics and nutritious diet which I have mentioned as useful in averting the sequelæ of measles, would be still more urgently called for after an attack of scarlatina.

During erysipelas of the head and face, in the severe form, the lids are so completely closed by the swelling of the skin, as to hide the eyes from observation. In the stage of debility succeeding the attack, ulceration of the cornea may arise, as in the two diseases above mentioned; or the cornea may even slough, as in scarlatina.

Of all the exanthemata, small-pox produces the greatest damage to the eyes; and a large proportion of those persons whom we see with shrunken globes, or with their corneæ converted into chalk-like ciatrices, have lost their sight from the ulceration induced by this disease. It was formerly supposed that these opacities were produced by pustules on the cornea itself; but it has been ascertained that pustules never form on this part, the opacities being invariably the result of ulcers, caused by the extreme prostration which succeeds the inflammatory stage.*

ULCERS OF THE CORNEA.

Under the various heads of *Purulent*, '*Scrofulous*,' and '*Exanthematous Ophthalmia*,' and in the section on *Keratitis*, I have mentioned the more formidable kinds of ulceration to which the cornea is liable. The cases, however, are very numerous in which corneal ulcers are developed in a more isolated manner than in any of the above mentioned diseases, being unattended with either purulent discharge from the conjunctiva, or general inflammation of the whole cornea.

Persons of all ages are liable to corneal ulceration. It is essentially a disease of debility, attacking those whose general power has been lowered by some exhausting illness, by bad or insufficient food, or some other depressing agency.

* For this important fact we are indebted to the extended observations of Mr. Marson, at the Small-pox Hospital. He has lately published the results of his vast experience up to the present time. Among 15,000 cases of small-pox, he has seen twenty-six instances of pustules on the eye-ball; but they have invariably appeared on the conjunctiva, never on the cornea.

In persons of feeble reparative power, an ulcer, instead of healing up to the level of the healthy cornea, sometimes forms a slightly-depressed cicatrix. It is of course most important not to confound these two conditions, as is often done by those unaccustomed to the observation of eye-diseases. A recent ulcer, in which the destructive process is still going on, presents a sharply-cut, well-defined edge, with little, if any, surrounding opacity, and the excavation itself, as regards transparency, offers but little contrast to the sound cornea. An ulcer which is healing is always more or less opaque throughout, and there is a cloudy halo surrounding it; and if the ulcer be large, vessels will be seen running to it from the edge of the cornea. A depressed cicatrix, on the contrary, has its edges smoothly rounded off, and its area is slightly opaque; there is little, if any, cloudy halo surrounding it, and seldom any plexus of vessels going to it from the corneal margin. In some cases, however, a depressed cicatrix is supplied by a small vessel or two, the remains of the plexus which once carried the material necessary for the healing of the ulcer which preceded it.

If the progress of an ulcer be not arrested, it may eventually perforate the whole thickness of the cornea. The aqueous humour then escapes, the iris falls forwards, so that the anterior chamber becomes altogether obliterated, a portion of iris—large or small, according to the size of the perforation—protrudes through the opening, towards which also the pupil is displaced. If the prolapsus iridis be very large, the whole area of the pupil may be annihilated.

In rare cases the ulceration stops short at the posterior elastic lamina of the cornea, which, in consequence of the pressure from behind, is thrust forwards as an almost transparent vesicle, filling up the cavity of the ulcer. The term *hernia corneæ* has been applied to this protrusion. It would at once be distinguished from a *prolapsus iridis* by the retention of the aqueous humour, and the consequent persistence of the anterior chamber.

There is one remarkable form of corneal ulceration—which I have seen only two or three times—of a singularly destructive and intractable character. In all of the cases the patients were men who appeared by no means debilitated, as far as their general health was concerned. One eye only was attacked; the ulceration commencing at the edge of the cornea, rapidly formed a deep crescentic groove, which continued to deepen and extend

itself, until it had completely isolated the central portion of the cornea, which was left standing up in high relief. This central portion eventually yielded to the ulcerative process, and sight was of course entirely lost. It was remarkable that in all the cases the posterior lamina of the cornea either remained unbroken, or was perforated to only a small extent. The form of ulceration was very similar to that accompanying gonorrhoeal ophthalmia; but there was no trace of purulent discharge. There was very little pain or uneasiness, and the amount of redness in the conjunctiva and sclerotic was but trifling. Probably some change in the tissue of the vessels supplying the globe was the cause of this rapid and uncontrollable ulceration.

Treatment.—I have said that corneal ulcers are almost always a result of general debility, and therefore their cure is to be sought rather by improving the general power of the patient than by local application. The exception to this rule is formed by those cases in which the ulcer is very large, exhibiting a total want of reparative action, and by those cases terminating in prolapse of the iris. In both of these instances, the local use of the solid nitrate of silver is often a very serviceable adjunct to the general treatment.

The mischievous effects of lead lotions, when applied to ulcers of the cornea, have been already alluded to (p. 66); and solutions of nitrate of silver, if used for too long a time, will also give rise to insoluble deposits, and consequent opacities.

While everything tending to improve the general health is to be resorted to in cases of ulceration, the occasional use of warm water to the eyes is commonly the best local application. The eye should be kept lightly covered; and if there be intolerance of light, or much pain in the eye, complete closure of the lids is indicated. This closure is especially necessary when either the iris has prolapsed, or a hernia corneæ has taken place.

I have already (p. 72) said how useless must be the attempt to push back a portion of iris protruding through a corneal ulcer. If the little nodule of iris soon becomes coated with an opaque layer of adhesive deposit, simple closure of the lids, and support of the general power by suitable diet and tonics, will suffice to cause the protruded iris to become adherent to the edge of the ulcer; after which, no further prolapse will occur. But if the protruding iris, instead of becoming coated with lymph, retains its natural colour and fibrous appearance, a touch with a fine

point of nitrate of silver will often set up sufficient inflammation to cause adhesive deposit to take place. In like manner the deep excavated ulcer, which sometimes forms in very anæmic and weakly persons, and threatens to perforate the cornea, or to destroy it by rapidly spreading all around its margin, may be arrested, and a healing disposition given to it, by lightly passing the solid nitrate over the whole excavation and edges of the ulcer.

OPACITIES OF THE CORNEA.

It is of the utmost importance as respects both prognosis and treatment, that the surgeon should make himself perfectly familiar with the varied appearances which corneal opacities assume. Without this knowledge, he will be constantly liable to deceive both himself and his patient, in promising the removal of opacities which are in their very nature permanent; or in pronouncing incurable, hazy conditions of the cornea, which, if promptly and skilfully treated, may be perfectly removed. To the latter class belong those cloudy opacities which I have described (p. 67) as overspreading the cornea in the slighter forms of simple keratitis. The short period, a few days or weeks, during which the cloudiness had existed, the presence of a vascular zone in the sclerotic, and some degree of irritability of the eye, would all point out the cloudiness of the cornea as being due to simple inflammatory deposit within its substance, which, under suitable treatment, may be so entirely dispersed as to leave the cornea in all its original transparency. If, on the other hand, the same amount of general haziness were known to have existed for a long time—say a year or more—if there were a total absence of sclerotic redness, and if the eye had long ceased to be irritable, the surgeon would know that the opaque condition of the cornea was incurable, and he would no longer attempt the use of stimulating lotions and ointments, which could only arouse fresh irritation and increase the existing mischief.

The haziness which sometimes remains after a severe and obstinate attack of keratitis, presents an appearance not easy to describe, but which the experience of a few cases will readily enable the surgeon to recognise again. There is a total absence of unnatural vascularity about the eye, but the whole cornea is slightly shaded with a faint haziness, with intervening spaces of almost transparent tissue, through which the colour and texture

of the iris and the form of the pupil can be recognised, although not in their natural distinctness. The dimness of sight in these cases seems to be out of all proportion to the amount of opacity; and the patient can perhaps merely see black streaks when looking at a page of type.

The terms *nebula*, *albugo*, and *leucoma* have been applied to corneal opacities, according to their different degrees of density; the slighter forms being distinguished as *nebulæ*; *albugo* and *leucoma* signifying rather the white opacity of cicatrices. The edge of a *nebula* is gradually shaded off into the surrounding clear tissue; that of a cicatrix, at least one of old standing, is more or less abruptly defined. Where a prolapse of the iris has taken place through a corneal ulcer, the leucoma which results is marked in the centre by a small blackish spot.

Treatment.—As regards the prognosis of *nebulæ*, their possible improvement mainly depends upon the age of the patient. In infancy, it is quite astonishing to see how the rapid interchange of material which is then going on, will diminish both the extent and the density of even large cicatrices. In an infant attacked with purulent ophthalmia, a cicatrix may at first be so large as to occupy the central third of the cornea, and yet, in after-life, a mere cloudy speck may remain opposite the centre of the pupil. At a later period of life, *nebulæ*, which form as the cicatrices of superficial ulcers, are more permanent; but around the denser part of the speck there is always a certain amount of cloudiness, which slowly disappears. The older the *nebula*, the more sharply defined is its margin.

Allusion has already been made to the permanent white deposit which occurs in corneal ulcers, when lotions containing lead have been employed. The metal is deposited in the state of carbonate, and forms a chalky-white layer on the ulcerated surface. Practice alone can enable the surgeon to recognise these old lead-deposits. They somewhat resemble a little patch of whitewash, their margin being sharply defined, and their surface often presenting minute cracks, through which the tissue of the cornea appears as dark lines. When the ulcer has been very superficial, and the metallic deposit lies just beneath the epithelium, the surgeon may sometimes succeed in scraping away the deposit; to do this, however, requires the utmost care and lightness of hand.

A very curious form of *calcareous deposit*—phosphate or carbonate of lime—between the cornea and its epithelium some-

times takes place without any previous inflammation. I believe this kind of deposit to be extremely rare, for, since I first noticed it in 1848,* I have seen only two other instances. From what I have already said concerning the nature of corneal opacities, the reader will perceive that when they are of old standing and unconnected with any existing inflammation, local treatment can avail but little. Setting aside those exceptional cases I have enumerated as removable by operation, the partial disappearance of old nebulæ is due to that change of material which is constantly going on in the human body, and which is so much more active in infancy and childhood than after the period of growth has terminated. The lotions, the drops, the vapours, the ointments, which crowd the pages of the older ophthalmic works, if not actually hurtful, as being likely to set up fresh irritation, are either altogether inert or at best they serve to amuse the patient while time is slowly clearing the opaque tissues.

INJURIES OF THE CORNEA.

Abrasion.—The epithelium covering the anterior surface of the cornea is liable to be torn or scratched by coming in contact with any rough substance; or a little flap of the epithelium may be partially detached and doubled down. Those who have not seen these slight cases of injury to the epithelium cannot imagine how much pain they produce, especially in persons of a sensitive nervous system. A clean cut directly through the cornea often causes far less pain than an abrasion of the epithelium so minute as to be scarcely discernible.

Within a short time after the epithelium has been injured, the sclerotic is often much injected, and a profuse flow of tears follows every attempt to separate the lids. The surgeon will best obtain a view of the part by placing the patient in a chair and standing behind him. As soon as the lids are widely separated, the pain almost ceases, and the surgeon must then carefully explore the whole surface of the cornea, while the patient moves the eye in various directions, so as to allow a bright light to fall on each portion in succession. A slight irregularity and roughness at one minute spot is often all that can be found to mark the position of the injury.

* My case was first published in the Appendix to Bowman's *Lectures on the Anatomy of the Eye*, 1849; and a second time in my *Guide to the Practical Study of Diseases of the Eye*, 1855.

The *treatment* of these abrasions is very simple. A drop or two of olive-oil or castor-oil may be applied to the abraded surface, and then the lids are to be kept closed with a light pad of cotton-wool, and a bandage, for four-and-twenty hours. As soon as the epithelium is regenerated all irritation ceases, and the uniform polish of the cornea is restored.

Contusion of the cornea.—Blows on the cornea which do not cut or lacerate, but merely bruise, its tissue, vary greatly in their results, according to the violence of the blow, and the age and vigour of the patient. In the severer forms of contusion, softening and suppuration among the fibres of the cornea will probably occur, and the part will afterwards exhibit more or less haziness. But in very feeble or old persons, the whole cornea may become softened and infiltrated with pus, and in such cases the pain is often very severe.

At length the cornea gives way, the aqueous humour escapes, and the pain immediately subsides; but the whole or the greater part of the cornea becomes pulpy and disintegrated, and comes away in shreds, and ultimately the globe shrinks, or else a staphyloma is formed. The worst cases of this kind occur among paupers engaged in stone-breaking. During such work, a pair of gauze-wire goggles should always be worn.

Treatment.—Even a slight contusion, if it takes effect at the centre of the cornea, must be regarded as a serious accident, on account of the suppuration and consequent haziness that may possibly ensue. We must take care, therefore, not to reduce the patient by bleeding and mercury, since by so doing the vitality of the cornea is lowered, and softening and suppuration are more likely to take place. An eye which has received a blow on the cornea should be kept closed and defended from light, and poppy fomentation may be used, if any pain comes on. If the case be seen early, a blister to the temple is sometimes useful as a counter-irritant. A narcotic may be required at bedtime; and the diet should not be reduced below that which is suited to the patient's ordinary condition.

The setting-in of suppuration, attended as it is with pain, would require an increased dose of the narcotic; and should the cornea give way, a tonic treatment, with a suitable proportion of stimulants, would become necessary, to limit the destruction of tissue, and afford material for repair.

Incised and punctured wounds.—Although cuts of the cornea are usually produced by sharp-edged or pointed bodies, they also occasionally result from sudden blows inflicted with blunt ones; and a smart stroke with a stick will sometimes inflict on the cornea a cut as clean as if made with a knife. Wounds of this latter description, however, on account of the shock given to the whole eye, are usually much more serious than those made with sharp instruments. A wound involving one-half of the corneal margin, such for instance as is made in the operation of extraction, may become completely united within three or four days, without inflammation occurring in any other tissue of the eyeball, whilst a much smaller cut produced by a blow with a stick or stone will be followed by severe and long-continued inflammation, ending in complete disorganisation of the globe. Small sharp bodies, such as fragments of metal or glass, when driven with great force and rapidity against the cornea, frequently produce so small a wound, that a surgeon unaccustomed to see such cases may be apt to underrate the size of the foreign body which has inflicted the injury; the elasticity of the corneal tissue causing the wound to contract as soon as the foreign body has passed through. When a case of this kind is seen immediately after the injury, the most careful scrutiny, with all the advantages of a good light, is often required to enable the surgeon to detect the wound. The whole surface of the iris, and especially the bottom of the anterior chamber, should be most carefully examined, in order to detect the lodgment of the penetrating body; and if the cornea be still transparent, and the aqueous humour retained, the pupil may be dilated with atropine, and the lens and deeper tissues explored with the ophthalmoscope. If any portion of the penetrating body protrude from the wound, it should be at once extracted with a fine well-closing forceps, the lids being held apart with a spring speculum, and the globe steadied by nipping up a fold of the conjunctiva covering the sclerotic.

When the wound of the cornea is large, a portion of the iris is frequently forced through the wound. If such a case is seen within a few hours of the accident, and before there has been time enough for the protruded iris to become united to the margins of the corneal wound by adhesive deposit, the portion of iris may sometimes be returned by careful pressure with a probe or small spatula. If, however, adhesion between the cornea and iris has already taken place, this reduction is

impossible ; and the surgeon must then content himself with maintaining the parts in perfect rest by keeping the lids closed ; or if the protruding and strangulated iris be indisposed to shrink, it may be lightly touched with nitrate of silver, and the lids again kept closed for some hours.

Sometimes the protruded portion of iris gradually becomes distended with aqueous humour, and assumes a rounded pouch-like form. This little pouch should be freely punctured, or a portion of it cut off with curved scissors, and then the nitrate of silver and the bandage applied as before.

The advice I have here given, as to returning the iris protruding through an incised wound of the cornea, may at first appear to be inconsistent with what I have before said, at page 72 ; but the difference between the two cases consists in this—that when an ulcer has perforated the cornea, there is an actual loss of its substance, and if the iris protruding through such an aperture be pushed back, it will escape again and again. But in the case of an incised wound there is no loss of corneal tissue, merely a separation of its fibres ; and if the protruding iris be returned into the anterior chamber, the elasticity of the corneal tissue will bring the edges of the wound into apposition, and keep them so until they have become united.

Punctured wounds of the cornea vary much in their character, accordingly as they are inflicted by means of pointed bodies of a large size, or by such small fragments as remain embedded among the fibres of the part. Wounds of the former class frequently involve other parts of the eye, and penetrate through the cornea into the iris or the lens. These complicated injuries cause either iritis or cataract, and will be spoken of in future chapters.

The simplest and by far the most common form of puncture of the cornea is that which happens when little fragments of metal or grit are forcibly projected against the eye, and remain sticking either in the epithelium or in the superficial layer of the cornea itself. Engineers, metal-turners, mill-stone dressers, stokers, are constantly liable to these injuries ; and the surgeon should be able at once to remove the foreign body without inflicting in the attempt any farther injury on the cornea. Standing behind the patient, who should be seated opposite a window, the surgeon raises the upper lid by placing the tips of his first and second fingers against the edge of the tarsus, beneath the cilia, and then pressing the lid upwards and backwards without everting it ; he then with these two fingers

steadies the globe by gentle pressure just above the cornea, while the point of the ring-finger gently presses the globe at its inner side. In the other hand he holds a little spatula-shaped instrument (which for want of a better name I have called a 'spud'), the flat end of which he passes under the foreign body, and so tilts it out. The point of a cataract-needle or a lancet, on account of its fineness and delicacy, is very unsuitable for extracting these little bodies. All the treatment necessary after their removal consists in keeping the eye closed for a day or so, with perhaps occasional fomentation.

If an elongated chip of metal strikes the eye obliquely, it sometimes wedges itself into the cornea at about the middle of its thickness, lying exposed to view, but so completely buried as to afford no hold to a forceps. The surgeon must with a cataract-knife or cutting-needle slit up the layer of corneal substance along the whole length of the foreign body, which can then be turned out without difficulty.

One of the injuries most difficult to treat is that inflicted by a sharp-pointed chip of metal just long enough to transfix the cornea, and to thrust its point into the anterior chamber, while the other extremity is so much embedded as to offer no hold for a forceps. If the surgeon attempts to dig out such a chip, he will almost certainly drive it farther in, until at last it slips wholly into the anterior chamber, and entangles itself among the fibres of the iris.

The removal of the foreign body will call for all the operator's skill and patience, and chloroform must be used if the patient be timid and unsteady. The lids being separated with the spring speculum, an assistant fixes the globe by nipping up with a forceps a fold of the conjunctiva at its lower part. The surgeon then, with a broad cutting-needle, makes an opening in the cornea close to its outer margin. The needle should be slowly withdrawn, without rotating it in the slightest degree, so that the aqueous humour may, as far as possible, be retained. Then a small spatula is to be passed in at the opening, and carried quickly and steadily across the anterior chamber, so as to interpose between the lens and the intruding point of the foreign body. The spatula is then to be pressed forward against the foreign body to keep it fixed, while, with a cataract-knife or cutting-needle held in the other hand, the surgeon slightly enlarges the wound on the anterior surface of the cornea. Still steadying the point of the foreign body with the spatula in the

anterior chamber, he endeavours with a very fine and well-closing forceps, to grasp the extremity of the foreign body and draw it out of the wound.

I have had occasion several times to perform this operation, which the minuteness of the foreign body, its close proximity to the transparent lens, and the necessity for limiting the extension of the external wound, combine to render one of the most difficult in ophthalmic surgery.

A foreign body, which passes quite through the cornea, may wound the lens and remain embedded in its substance, producing a traumatic cataract; or it may become fixed in the iris; or, having lost its momentum in traversing the cornea, it may fall down to the bottom of the anterior chamber. Under any of these conditions, if the surgeon sees the case immediately after the accident, while the cornea is still clear, and the iris and anterior chamber are not yet obscured by inflammatory effusions, he should endeavour at once to extract the foreign body. If it can be distinctly seen sticking in the lens, it will be right to make a section of the upper half of the cornea, and remove the lens, as in the ordinary operation for cataract. A chip of metal, fixed in the iris, may be removed with Assalini's spring-forceps,* or the cannula-forceps, introduced through a small corneal wound; and in the same manner foreign bodies of any kind, which are lying loose in the anterior chamber, may be seized and extracted.

The surgeon must not be deterred from attempting to remove these foreign bodies by the stories he will find in many of the older ophthalmic works, about the oxidation, and solution, or encysting of metallic fragments. The lymph which is thrown out around a metallic chip in the iris does indeed, for a time, encase it and hide it from view; but this is only the beginning of a tedious iritis, which will probably end in disorganisation of the eye, or, at least, produce obstruction of the pupil and loss of sight.†

* This instrument was invented by Assalini for seizing the iris in the operation for artificial pupil; *Ricerche sulle pupille artificiali*, &c. Milano, 1811. For this purpose it has been superseded by the more delicate *cannula-forceps*.

† In a case I communicated to the *Dublin Journal of Medical Science* (n. s. vol. vi. p. 210, 1848), a very minute scale of copper remained fixed in the iris for *eight years*, and, after causing repeated attacks of iritis, was at last thrust forwards against the cornea by the effused lymph; ulceration was set up, and the little fragment, projecting through the cornea, was seized and extracted.

Foreign bodies lying loose in the anterior chamber are to be removed in a similar way to that I have just recommended in the case of bodies fixed in the iris; the extent of the corneal incision being of course proportioned to the bulk of the body to be extracted.

This may perhaps be the most convenient place to notice those rare cases in which a living entozoon constitutes the foreign body in the anterior chamber.

The *Cysticercus telæ cellulosæ* has been repeatedly met with in this situation, as a rounded, semi-transparent, vesicular body, furnished with a long retractile neck, terminating in a head furnished with suckers and a circlet of hooks. If not removed, the animal eventually sets up inflammation of the iris and cornea, which ends in total loss of vision. A crescentic incision along the edge of the cornea allows of the escape of the animal along with the aqueous humour. Cases have been reported by many ophthalmic writers, among whom Mackenzie has given the fullest details, and has figured the animal both in its natural condition and magnified.*

All the operations on the cornea just described will be greatly facilitated by the use of the spring speculum, a forceps to fix the globe, and, in irritable and timid patients, by the administration of chloroform.

The *after-treatment* of all the foregoing cases, in which an incision of the cornea may have been necessary for the removal of a penetrating body, mainly consists in keeping the eye

* Mackenzie (*Practical Treatise*, &c. 4th edit. 1854) quotes a case of *cysticercus* in the anterior chamber, observed by Schott in 1830; another by Logan in 1833; and relates two cases of his own in 1848 and 1850, and two others in the practice of other surgeons. He also mentions a case reported by Appia, in which the *cysticercus* is *said* to have been seen within the substance of the cornea. In all these instances the *left* eye was affected, and Mackenzie remarks that 'the left has suffered much oftener than the right eye from the intrusion of *cysticerci*, either under the conjunctiva or into the interior of the organ.' Cases which have been reported subsequently to the publication of Mackenzie's work do not, however, bear out this statement. In the *Archiv für Ophthalmologie*, vol. i. p. 453, is a case of *cysticercus* in the *right* anterior chamber; and in the same journal, vol. iv. p. 113, is another, also in the right eye; Teale has reported a case occurring in the right eye; *Ophthalmic Hospital Reports*, vol. v. p. 320. When Mackenzie wrote, *cysticerci* had never been discovered in the *vitreous* chamber; but in the *Archiv* twenty cases have already been reported, nearly equally divided between the right and left eyes. (See a subsequent note on *cysticerci* on the retina and in the vitreous humour.)

perfectly at rest and protected from light, while the healing process is going on. For the first twenty-four hours at least, *both* eyes should be covered with a light bandage. After that period it may be sufficient to keep the wounded eye closed, and the length of time during which this closure should be maintained must depend upon the rapidity with which the wound heals, and the aqueous humour is resecreted—circumstances varying according to the constitution of the patient, and the amount of violence inflicted on the eye by the accident and the subsequent manipulations of the surgeon. Patients should neither be kept low nor over-stimulated, but maintained as near as possible at their natural standard of vigour. Those of an irritable temperament will often require a narcotic for several nights after these operations; but if chloroform has been used a narcotic should not be given while the system is still under the effects of the inhaled vapour.

CHAPTER V.

DISEASES OF THE SCLEROTIC.

INFLAMMATION.

(*Rheumatic Ophthalmia* of Mackenzie; *Scleritis*; *Sclerotitis*.)

THE sclerotic is inflamed to a certain extent in all cases of keratitis and iritis, and exhibits that zone of red vessels close around the margin of the cornea which is so marked a symptom of both these diseases. A more extended inflammation of the sclerotic not uncommonly forms one of the complications of catarrhal ophthalmia.

But there is also a form of inflammation which is almost limited to the sclerotic, the conjunctiva being implicated only in a secondary degree, and this sclerotic inflammation may assume either the acute or the chronic form.

In the acute inflammation the whole of the sclerotic is intensely injected, the part assuming a peculiar pink tint, quite different from the more vermilion colour of conjunctival inflammation. In very severe cases the pink tint has a shade of violet, in consequence of the depth at which the vessels lie in the fibrous tissue. Intolerance of light and lacrymation are

marked symptoms, and in and around the eyeball there is always considerable pain, which sometimes assumes the form of intense neuralgia throughout the ophthalmic division of the fifth nerve, extending even into the second and third divisions.

The attack is attended with general constitutional derangement; the tongue is coated, the appetite bad, and the urine often deposits large quantities of lithates.

Treatment.—The bowels must be first thoroughly cleared, and then narcotics given, in doses proportioned to the severity of the neuralgia and the former habits of the patient. Half a drachm, or a drachm, of tincture of hyoscyamus may be sufficient in some cases, while in others full doses of morphia will be requisite to insure sleep. In some patients quinine, in others iodide of potassium, is of great service; to those in whom the rheumatic diathesis is more marked, colchicum given in combination with an alkali will be far more beneficial. The patient's appetite is usually so bad that it requires management to induce him to take sufficient nourishment. Beef-tea, bread-and-milk, and various modifications of farinaceous food, are often more readily taken than solid meat. Sugar should be avoided, and beer, as containing sugar; dry wine or diluted spirit being substituted, and of course only given in quantities demanded by the condition and previous habits of the patient. Local depletion by means of leeches seldom produces more than temporary benefit, and blisters only aggravate the neuralgia. Steaming the eyes over hot water is usually soothing, and preferable to fomentation, in consequence of the extreme irritability of the surface of the eye. The most effectual local application is chloroform, diluted with olive-oil according to the susceptibility of the skin, and applied on lint to the temple and forehead. The patient's room should be moderately shaded from light, and the eyes still farther protected, if necessary, by a suitable eye-shade, or tinted spectacles; but complete darkening of the room is unnecessary, and it has the great disadvantage of rendering the examination of the eyes by the surgeon intensely painful during the abrupt transition from darkness to light.

Chronic inflammation of the sclerotic occurs frequently, but by no means exclusively, in rheumatic subjects. Instead of involving the whole extent of the sclerotic at once, it commonly appears as a limited patch of redness, close to the cornea, after a time fading away, and then reappearing on some other portion

of the white of the eye, but always keeping close to the corneal margin.

When this chronic inflammation of the sclerotic has gone on for a long time, it has a tendency to involve either the cornea or the iris. In the latter case the iritis is so insidious and so slightly marked as frequently to be overlooked; and it is not until after the sclerotic redness has wholly disappeared that some dimness of vision induces the surgeon to make a careful examination of the pupil; when he will probably detect some small adhesions between the iris and the capsule of the lens, or a filmy opacity of the latter, dotted with minute patches of pigment.

It appears to be this form of obstinate sclerotic inflammation which Wilde* has described as 'inflammation of the ciliary body.' No evidence, however, exists that this structure is specially the seat of inflammation.

Treatment.—Chronic inflammation of the sclerotic is a very tedious affection, and one that is extremely liable to recur, if the patients are exposed to cold and damp, or fall into that dyspeptic condition which induces chronic rheumatism. Strict attention to diet, avoidance of sugar, and substances which form sugar in the system, a dry and temperate climate, will be the best means to prevent the sclerotic inflammation from becoming periodical in its return. Quinine is commonly the most effectual remedy, and blisters to the temples are often valuable adjuncts. But if the patches of redness shift about from one side to the other, fading away at one part, only to reappear at an opposite point of the globe, a vigilant watch should be kept upon the iris, lest it should be attacked with inflammation. If the pupil becomes sluggish and slightly irregular, a careful examination with concentrated light will probably reveal a very slight, barely perceptible, deposit of lymph fringing the pupillary margin. The sight will at the same time be more or less cloudy. In such a case mercury must be carefully given to check the iritis. Two grains of calomel with half a grain of opium may be given at bedtime; or, if the iritis be more acute, and the deposit of fibrin more considerable, the calomel and opium may be given for a few days, night and morning; and as soon as the deposit begins to be absorbed, the dose may be restricted to two grains a day, or even that quantity may be

* *Medical Times and Gazette*, n. s. vol. ix. p. 515, 1854.

given on alternate days. In delicate subjects a single grain taken every night may be sufficient from the first. The mouth must never be made at all tender, and the depressing influence of the mercury may be counteracted by a daily dose of bark, and a moderately nutritious diet. The bark should be continued in small doses for some weeks after the mercury has been left off.

INJURIES OF THE SCLEROTIC.

Clean cuts of the sclerotic, inflicted with sharp bodies of various kinds, frequently involve the subjacent structures, the choroid and retina. If the latter be extensively divided, a greater or less quantity of the vitreous humour is almost sure to be lost. The laxity of the conjunctiva, however, often serves to limit the escape, as the tenacious fluid becomes entangled among the meshes of the sub-conjunctival areolar tissue.

The prognosis of wounds of the sclerotic depends upon their extent, the amount of vitreous humour which has been lost, and, above all, upon the fact whether or not the foreign body inflicting the wound has penetrated into the interior of the globe. The wound made by the entrance of a grain of shot is usually very small, as the elasticity of the sclerotic causes its fibres, after being separated by the shot, instantly to close up again, as soon as it had passed through them. When quite recent, a shot-wound in the sclerotic is hidden by a little patch of blood extravasated beneath the conjunctiva. The entrance of a grain of shot, or a fragment of metal, through the sclerotic into the vitreous chamber is almost certain to set up a slow inflammation of the whole globe, ending in loss of sight and atrophy of the organ.

Simple punctures and small cuts through the sclerotic, unattended with the retention of any foreign body, commonly unite very well, provided the eye be kept in perfect rest, and the reparative process be not interfered with, and checked by injudicious applications, or by general depletion and weakening of the patient's system. It seems almost superfluous to insist upon the necessity for absolute repose for the wounded organ; and yet it is wonderful to see how the good sense of the surgeon, who would treat a fractured limb on the principle I have just mentioned, seems to desert him as soon as a wounded eye comes under his care.

Rupture of the sclerotic with displacement of the lens.—A very remarkable injury sometimes happens to the sclerotic, consisting in a laceration extending completely through its substance, within a line or two of the corneal margin, while the conjunctiva remains unbroken, and the dislocated lens, slipping out through the rent in the sclerotic, becomes firmly wedged beneath the conjunctiva.

This rupture of the sclerotic always takes place on the side of the eye opposite to that which has received a severe blow with some blunt body; the fibres, being suddenly put on the stretch, give way at the point where they are the most bent. Hence it is that the seat of rupture is almost always either the upper or the inner part of the globe, the lower and the outer portions being comparatively exposed to violence, while the prominence of the eyebrow above, and of the nose internally, defends the upper and the inner portions.

Rupture of the sclerotic, with sub-conjunctival dislocation of the lens, is always attended with some injury to the iris. Either that portion adjacent to the sclerotic wound is drawn into it, the pupil remaining large, and displaced towards the margin of the cornea, or else the shock causes the ciliary attachment of the iris to give way to a greater or less extent.

It sometimes even happens that the whole ciliary attachment gives way, and the entire iris is driven completely out of the globe, through the rent in the sclerotic, along with the aqueous humour, lens, and a portion of the vitreous body. This large escape of the contents of the globe only takes place, I believe, when the conjunctiva is also ruptured.*

When a recent case of ruptured globe is seen soon after the infliction of the injury, the parts are so obscured by blood that it is often impossible to form a correct estimate of the damage the globe has sustained. Detachment of the iris from its ciliary connection is always attended with bleeding, which may completely hide everything behind the cornea. The lens, too, if dislocated beneath the conjunctiva, is often enveloped in blood, so that its form cannot be precisely defined. Until the blood behind the cornea has been absorbed, it is impossible to ascer-

* See two cases in which the lens and iris were driven out of the eye through the ruptured sclerotic, published in my *Practical Guide*, &c., 2nd edit., pp. 398-9. Also a case of sub-conjunctival dislocation of both lenses in the same person, p. 113, *note*.

tain whether the retina has retained its function; so that in every case the prognosis will be extremely doubtful.

Treatment.—If the detached iris is hanging out of the wound through a rent in the conjunctiva, it should be snipped off with scissors; but inasmuch as the lens, if lying between the unbroken conjunctiva and the sclerotic, may be so obscured by effused blood as to be with difficulty recognised, it will be well to wait a few days until the blood has become absorbed, and then the division of the conjunctiva covering the displaced lens will allow of its easy removal.

Absolute rest of the eye is the one important point in the treatment of all cases of ruptured globe. For the first few days, both eyes should be kept closed, by means of strips of plaster or a light bandage. Afterwards, it will suffice to close the injured eye only; but this closure should be uninterruptedly maintained for a week or ten days.

The patient should not be kept on low diet, nor depleted in any way; least of all should he be brought under the action of mercury, as is too often done. Such treatment can only have the effect of lowering his reparative power, and so retarding the process of cure.

CHAPTER VI.

DISEASES OF THE IRIS.

CONGENITAL DEFECTS.

(*Irideremia; Coloboma; Misplaced pupil; Persistence of membrana pupillaris.*)

CONGENITAL absence of iris (*irideremia*) always attracts the notice of those about the infant by the peculiar reddish glow which is reflected from the retina. The child seems to shrink from strong light, and there is a good deal of unsteadiness of the globes. The whole space behind the cornea presents one uniform red or orange tint, while the edge of the lens is marked out by a ring of golden light.

Although the term *irideremia* would imply a total absence of iris, a slight rudiment of it is often found, forming a very narrow segment of a circle skirting some portion of the edge of the cornea.

Considering that a certain number of infants affected with this rare malformation are yearly brought for an opinion to our public eye-hospitals, it is singular that an adult thus affected is so seldom met with. I can only remember to have seen one such case, a short notice of which I published a few years ago.*

Coloboma.—This congenital malformation is the result of an arrest of development, whereby the coalescence of the two halves of the iris is prevented; the pupil, therefore, presents an elongated form, and extends down to the lower edge of the cornea.

A median fissure of the lower portion of the choroid accompanies *Coloboma iridis*. The iris and choroid being formed in the embryo from one vascular membrane curved upon itself, an arrest of development causes in both structures the same kind of defect along the median plane of the eyeball.

Coloboma iridis, however, is not always placed exactly on the median plane of the eye, but sometimes a little to the inner or outer side of it. It usually co-exists in both eyes, although not always in the same degree. Sometimes, instead of the pupil being prolonged down to the bottom of the cornea, an abortive attempt, as it were, to form a coloboma is evidenced by a puckered groove in the iris, extending downwards from the lower edge of the pupil. The actual size of the pupillary aperture in coloboma is not always quite so great as, on a superficial inspection, it appears to be; for the extreme edge of the aperture, when minutely examined, will sometimes be found to be fringed with a blackish-brown pigment; and this at first sight produces the effect of a larger area than really exists.

An old prolapse of the iris through an ulcer, situated at the lower edge of the cornea, by drawing the pupil directly downwards, may produce an appearance a good deal like a *coloboma*

* *Guide to the Practical Study*, &c. 2nd edit. p. 400. Samuelson describes a case of *irideremia* in a man of forty-eight. Not only were the irides absent, but the closest scrutiny failed to detect any ciliary processes. His accommodation seems not to have been tested; but he asserted it to be perfect; *British Med. Journal*, 1863, p. 495. In the *Monatsbl. für Augenheilk.* 1866, *irideremia* is noticed as existing in a woman of forty-two. Her eldest child had the same defect. Hulme reports a case in a man aged twenty-two. He could read No. 6 of Jæger's test-types; *Med.-Chir. Trans.* vol. xlv. France gives another case, a woman aged twenty-three; *Guy's Hospital Reports*, vol. vii.

iridis. The white cicatrix, however, in the former case, would always enable the careful surgeon to recognise the true character of the deformity.

Another abnormal condition of the pupils consists in their being placed near the margin of the cornea, instead of opposite to its centre. Mal-position of the lens appears frequently to accompany this eccentric position of the pupils.*

Persistence of the foetal *membrana pupillaris* has been described as sometimes causing an obstruction in the pupil which might be mistaken for congenital cataract; but no practised observer could make such a mistake; for the *membrana pupillaris* is attached, not to the margin of the pupil, but to the anterior face of the iris, at a little distance beyond, where there is a more or less elevated ring of small tufts or nodules. Projecting from this part of the iris, I have occasionally seen slight vestiges of the pupillary membrane, in the form of little spurs or tags.

The persistence of any portion of this membrane, even in young persons, is a circumstance of extreme rarity. Dr. Cohn, in the *Klinische Monatsblätter für Augenheilkunde*, 1867 (p. 62), enters into an analysis of the cases published by different authors, and dismisses all of them except five as originating in a faulty diagnosis. He describes four cases from his own observation. I think there can be no doubt that, in most of the instances reported, old adhesions, the result of bygone iritis, have been mistaken for shreds of the *membrana pupillaris*.

The following case appears to be worthy of record, as exhibiting a vestige of the pupillary membrane in a person of middle life.

In the summer of 1867, a lady, aged thirty, consulted me for short-sightedness. The case was a very simple one, the myopia not in any high degree, and suitable glasses were all she required. I noticed a fine hair-like thread running obliquely across the pupil of the right eye, and at once recognised it as a vestige of pupillary membrane. It gave the patient no inconvenience, and indeed she could not be made aware of its existence under any illumination I could apply. Fig. *a* represents the eye with the pupil in its natural state, and Fig. *b* after atropine. I had expected to find that, as the pupil dilated, while the two sides of the iris were held together by the little thread, the aperture would become irregular; but this was not the case to any appreciable extent. The iris, of a thoroughly healthy appearance, was of a rust-brown, and the filament was only a little paler in colour. At each end it had a bifid attachment, and looked like a portion of the proper fibrous tissue of the iris drawn

* Figures of unusually extensive coloboma iridis, and of congenital mal-position of the pupils, illustrate a paper of mine in the *Ophthalmic Hospital Reports* for 1858 (plate iv. figs. 2 and 3).



In the *Albino* the iris partakes of the general want of coloured pigment which characterises the hair and skin. The layer of opaque pigment, termed *uvea*, is altogether wanting, and the structure of the iris presents a singular appearance, as if loosened by maceration. Whitish fibres are intermixed with others of a lilac colour, and through the whole attenuated iris the light reflected from the fundus of the eye transmits a reddish glow.

Albinism is frequently attended with defective vision, and always with great intolerance of light. In some cases, however, sight is very good, and extreme sensibility to light is the only thing complained of.

INFLAMMATION OF THE IRIS—IRITIS.

Before entering upon this very important subject, it will be desirable to say a few words about the appearances which the iris presents in a healthy state; for it is subject to many variations as to colour and mobility, which, if not rightly understood, may lead to serious errors of diagnosis; mere congenital peculiarities, or changes incident to age, being mistaken for signs of disease.

The iris presents every shade of bluish-grey and brown among the fair and the light-brown races of mankind; whilst among the negro races it is uniformly found of a dark brown, approaching to black. A parti-coloured iris is not very rare; a fourth, a third, or even half of its surface being brown, and the rest bluish-grey: or one iris may be wholly brown, and the other as entirely grey, each eye being perfectly normal in respect of sight. Light-brown irides are often marked with two or three isolated tufts of dark pigment, and these spots are frequently causes of alarm to those who are the subjects of them.

* This case has been already published in the *British Medical Journal*, March 20, 1869.

every movement of the eyeball in some persons, who nevertheless enjoy good sight; but this tremulousness must be regarded as morbid, whenever it exists to any great extent. It is quite independent of the movements of the pupil, and is best seen when that aperture is contracted, as a larger extent of iris is then open to observation. As a decidedly morbid appearance, tremulousness of the iris is familiar to us after those cases of extraction of cataract, where much vitreous humour has been lost, or after needle-operations, where that humour has been rudely stirred up and disintegrated.

The pupil is not placed precisely in the centre of the iris, but a little nearer to the median plane of the body; so that the iris is rather narrower between the inner edge of the pupil and inner margin of the cornea than on the outer side of the pupil.

Any considerable deviation of the pupil from a circular form may be regarded as the result of disease; but the pupil may exhibit, especially in elderly persons, a slight irregularity of outline, without any disease having existed in the iris.

The mobility of the iris becomes less as age advances; and, in old people, we often find a small and almost fixed pupil, the sight remaining excellent. In examining the mobility of the pupils, each one should be tested separately, the other eye being closed; for such is the sympathy between the two organs, that when, in consequence of disease in the nervous apparatus, an eye has become quite insensible to light, its pupil, otherwise motionless, will contract whenever light is admitted to the sound eye.

The earliest mention of *iritis* occurs in a treatise by Schmidt, describing the inflammatory changes consequent upon cataract-operations as performed in his day.*

It is impossible to overrate the importance of inflammation of the iris; for when we consider that the visual function of the eye ceases, if the small aperture of the pupil becomes closed, we at once appreciate the consequences of inflammatory effusion into its area.

The attention which has been bestowed upon iritis by ophthalmic writers has led many of them to indulge in minute and tedious subdivisions of the disease, and to distinguish them by complicated terms, which only serve to embarrass and

* *Ueber Nachstaar und Iritis nach Staaroperationen*, 1801.

confuse the practitioner. The extent to which this evil has spread can be fully appreciated by those only who are familiar with German medical literature.*

This passion for subtle refinements and nomenclature has been comparatively rare with English writers; and those whose practical experience has been the most extensive have made use of the simplest classification.

Lawrence divides iritis into *acute* and *chronic*, and limits its constitutional modifications to four, the *syphilitic*, the *gouty*, the *rheumatic*, and the *scrofulous*. Tyrrell adopts the same arrangement.

There are certain signs common to all cases of iritis, under whatever constitutional modifications it may be developed; such are, a well-marked sclerotic zone; diminished mobility of the pupil, with more or less change in its form; a loss of the peculiar fibrous appearance of the iris; and a change in its colour.

Other signs mark the peculiar constitutional influence which has given rise to inflammatory action in the part. These will be noticed under the proper heads.

TRAUMATIC IRITIS.

Incised wounds of the iris are not the injuries which cause the greatest amount of inflammation in its tissue. On the contrary, clean cuts, even if very extensive, produce but little inflammatory reaction; while bruising, or continued pressure of the part, such as occurs in certain displacements of the lens, invariably gives rise to inflammation and adhesive deposits.

The wounds which are sometimes accidentally inflicted on the iris during the operation for extracting a cataract, or those which are intentionally made, to form an artificial pupil, are rarely followed by iritis; and when, after a few days, the eye is examined, more or less blood may be found at the bottom of the anterior chamber, but the fibrous tissue of the iris will present almost its ordinary aspect.

The lodgment of a foreign body, however, even of the smallest size, always sets up iritis, which does not permanently cease until the foreign body has been removed. As foreign bodies,

* For remarkable instances of this mania for subdivisions and uncouth names, see the work of Von Ammon, *De Iritide*, 1836; and that of Rau, *Die Krankheiten und Bildungsfehler der Regenbogenhaut*, 1844.

before reaching the iris, must have passed through the cornea, I have thought it best to treat of them in Chapter IV., under the section 'Injuries of the Cornea.'

A singular accident which sometimes befalls the iris may be mentioned in this place, although it is really attended with very little iritis, namely, detachment of the iris from the ciliary ligament. The organic connection between these two structures is so slight that a smart blow with a stick or a whip, the rebound of a twig, or the shock of a spent shot, is sufficient to sever them from each other; the extent of the separation varying in every possible degree, from a mere hair's-breadth to the complete detachment of the whole iris from its ciliary connection.

A very slight separation may almost escape notice. It appears as a small, black, elongated mark, close to the extreme edge of the cornea. In proportion to the extent of the separation will be the amount of deformity of the pupil; and when half of the circumference of the iris has been detached, the pupil will probably fall together and be wholly effaced.*

In all extensive cases of detachment, there is bleeding into the anterior chamber; sometimes to such an amount as at first to conceal the injury from view.

Unfortunately the surgeon can do very little in these cases. To replace the detached iris is utterly impossible, and vision must inevitably remain greatly impaired; but at least he can abstain from attempting to hasten the absorption of the effused blood by administering mercury. It may seem unnecessary to caution any one against such practice, but, in fact, the dogma that 'mercury induces absorption,' is so firmly fixed in some minds, that instances are constantly occurring of patients being actually salivated as a means of promoting the absorption of blood which is filling the anterior chamber after rupture of the iris. The rational mode of treatment is to defend the eye from strong light, and to keep the general vigour of the patient up to a healthy point, and then nature will in due time completely absorb the blood, without any aid from drugs.

I have observed how readily the iris inflames when subjected to long-continued pressure. The most striking examples of this

* The appearances presented by separation of the iris from its ciliary attachment may be seen in most of the illustrated ophthalmic works. I may instance Mackenzie's *Treatise*, 4th edit. p. 396; Cooper, *On Wounds and Injuries of the Eye*, 1859, pp. 170, 173, 175; Lawson, *Injuries of the Eye, Orbit, and Eyelids*; 1867.

are seen, when, in consequence of a blow upon the eye, the lens has been loosened from its connections, and partially dislocated into the pupil. The traumatic iritis is still more severe, if there be, at the same time, an incised wound of the cornea. In that case, the aqueous humour drains away, and, in consequence, the iris becomes compressed between the cornea and the displaced lens.

Inflammation of the iris soon sets in; vessels become visible in its tissue, and lymph is effused into the pupil, into which the lens is bulging. The cornea becomes hazy, and is traversed by vessels. The sclerotic and conjunctiva are deeply injected, and there is abundant secretion of tears. If the case be left to itself, or injudiciously treated, the pupil becomes eventually closed with effused lymph; or else the cornea softens and gives way. Meantime the deep tissues become disorganised, and, after protracted suffering, the patient finds the eye utterly useless.

The only way to anticipate all this mischief is to remove the displaced lens, which is acting like a foreign body. To do this requires much tact and care, and, in making the requisite opening in the cornea, the surgeon must endeavour to avoid isolating any considerable portion of corneal substance between his incision and the wound already existing in the cornea, lest the isolated portion should slough from interrupted nutritive supply. Sometimes the wound in the cornea is so placed that the surgeon, by enlarging it, can make an opening sufficient for his purpose. But if the wound be in the centre of the cornea, it is usually desirable to make the incision in a new portion, and as near the margin as possible. If the substance of the lens has been much broken by the original injury, the greater part of it will probably escape when pressure is applied; but if the lens be almost entire, it must be broken up as much as possible before any attempt at pressure is made. The use of the scoop will greatly facilitate the removal of the disintegrated lens, the pulpy substance escaping along the groove. In some cases the removal of a portion of iris will not only facilitate the removal of the lens with the scoop, but will prevent the occurrence or continuance of iritis.

The success of such an operation will depend upon its being performed soon after the accident, while the cornea is still clear, and before iritis and effusion of lymph have set in. If performed at a later period, there will be greater risk of vitreous humour

being lost. In all cases the success of the operation, as regards restoration of sight, must be very doubtful; and if performed at a late period, relief of pain, and prevention of complete disorganisation of the globe, will probably be the best result that can be hoped for.

The treatment, after such an operation as I have just noticed, will be similar to that after an ordinary case of extraction of a cataract. Closure of both eyes for four or five days will be necessary, and the reparative powers of the patient must not be depressed by privation of due nourishment.

The surgeon must not deceive himself with the belief that in these cases of wound of cornea, with displaced lens, the administration of mercury can avert destructive inflammation. The efficacy of mercury in controlling the effusion of lymph in non-traumatic iritis, arises from the fact of there being, in that case, no foreign body—which a displaced lens really is—pressing against and irritating the iris. *Traumatic iritis*, set up by a displaced lens, is wholly beyond the powers of mercury, and its administration can only do harm, by lowering the patient's reparative power, and so unfitting him to recover from the operation, should removal of the lens be ultimately resorted to.

RHEUMATIC IRITIS.

Rheumatic inflammation of the iris assumes either an *acute* or a *chronic* character. In the former case, the attack can usually be traced to exposure to cold wind or damp, when the body has been exhausted by fatigue or greatly overheated.

According to the nervous susceptibility of the patient, the onset of an attack of rheumatic iritis will be attended either by dull pain in and around the eyeball, or by acute neuralgia throughout the first division of the fifth nerve, extending even to the second and third divisions.

When the attack is severe, there is usually a good deal of intolerance of light, and lacrymation. The vascular zone is not well-marked, on account of its being lost in the general injection of the whole sclerotic, which assumes the purplish tint I have described as characterising sclerotic inflammation.

Rheumatic iritis is almost always attended with some slight haziness of the cornea, and in this respect it differs remarkably from the syphilitic form, which, even in the most severe cases,

often leaves the cornea perfectly clear. The morbid changes in the iris itself are sometimes so slightly marked as to escape an unpractised or a careless observer; so that it is not until the inflammation has subsided, and the cornea has become quite clear, that the still-existing impairment of sight causes a more careful scrutiny of the pupil to be made, and then inflammatory exudation into its area, and adhesion of its margin, are found to have taken place.

In the more acute form of rheumatic inflammation, the veins of the iris may be traced on various parts of its surface, as delicate red lines, diverging from the edge of the pupil to the periphery of the iris. I need hardly say that these fine vessels cannot be traced if there exists any considerable haziness of the cornea.

The pupil is contracted, more or less irregular, and as the inflammation goes on, this irregularity becomes more marked, in consequence of effusion of lymph* taking place between the edge of the pupil and the capsule of the lens. The insidious manner in which this fibrinous effusion occurs affords a marked contrast to the rapidity with which large masses of yellow or reddish-yellow lymph show themselves on the edge of the pupil in syphilitic iritis.

I have already noticed the neuralgia throughout the region supplied by the ophthalmic division of the fifth nerve, which attends an acute attack of rheumatic iritis. There is also very frequently considerable febrile disturbance, the urine being loaded with lithates.

The majority of cases do not present such acute symptoms as those just described, but pursue a more chronic course. The injection of the sclerotic being less general, the vascular zone around the cornea is better marked; there is little, if any, intolerance of light or lacrymation, and instead of severe neuralgia

* In describing iritis, I shall frequently have occasion to speak of that exudation from its vessels which constitutes the most serious feature of the disease, by forming adhesions between the pupillary margin and the capsule of the lens, or wholly blocking up the area of the pupil with opaque membrane. Whether this *exudatum* becomes itself converted into fibrous tissue, or whether it only influences the cells of the tissue among which it is effused, and causes new cells to be developed from those already existing, is a physiological question which can hardly be decided. I have used the term 'lymph' to describe this *exudatum*, because the word is familiar to all my readers, and is sanctioned by long usage.

in the fifth nerve, there is only a dull aching pain in and around the eyeball.

But, whether the iritis be acute or chronic, there is still the same danger of effusion of lymph into the area of the pupil, and this danger is, as I have said, all the greater on account of the gradual and insidious manner in which the effusion takes place. To check this is the main object to be kept in view.

Treatment.—If the early stage of acute rheumatic iritis be attended with severe neuralgia, as is frequently the case, the treatment will be much the same as that which I have described in Chapter V., as suitable to acute inflammation of the sclerotic. In some patients iodide of potassium, in others colchicum, will be of most service; while some cases, characterised by visible enlargement of the veins of the iris, yield to turpentine. I have usually given the Chian turpentine in substance, as pills, four grains three times a day. The condition of the pupil must be carefully scrutinised from day to day; and if it be found irregular and angular, or if any brownish tags appear to be forming at its edge, mercury must at once be given. Two grains of calomel, with a third or half a grain of opium, may be taken night and morning; and should any tenderness of the gums begin, the quantity ought at once to be diminished; for if salivation be allowed to occur, the neuralgia is almost certain to return, and the mercury, which in small doses was so beneficial, begins at once to exert its depressing influence. In delicate subjects it is often very useful to give a dose of bark—Battley's liquor cinchonæ or quinine—in the middle of the day, during the time the mercury is being taken. During the inflammatory stage the pupil is to be kept under the action of atropine.

It is almost impossible to lay down precise rules about diet. It should not be *low*—that is to say, innutritious—but light and easily digestible: soup, bread-and-milk, farinaceous food of various kinds, with or without a proportion of meat, according to the patient's digestive powers and previous habits. Stimulants should be given only in such quantities as may be necessary to sustain the circulating forces. Feeble and depressible persons may require a certain amount of dry wine, or diluted spirit, while those addicted to habitual indulgence may only eliminate the rheumatic poison which they have stored up in their blood, by abstinence from the alcohol and sugar they have so long abused.

Occasional steaming of the eye over hot water is the most

soothing local application, and where neuralgia is present, is preferable to fomentation by means of wetted compresses.

Leeches to the temples may occasionally be found useful at the onset of an acute attack; but where neuralgia exists they commonly do harm, and they should never be applied to feeble and depressible subjects, or those liable to erysipelas. Blisters also have the disadvantage of exasperating neuralgia. They are, however, very serviceable in the chronic form which often succeeds the acute attack, and they certainly aid in removing that haziness of the cornea, which, if not promptly dispersed, is apt to become permanent.

SYPHILITIC IRITIS.

Inflammation of the iris originating in syphilis is very frequently associated with other forms of secondary or tertiary disease, especially with eruptions on the skin. It is by far the most marked kind of iritis, and is characterised by a tendency to rapid and abundant inflammatory exudation on the iris, especially about the edge of the pupil, in which situation yellow, reddish-yellow, or nearly red nodules sometimes attain to such a size as almost to close up the pupillary area.*

The cornea is either clear, or marked throughout its lower half by very minute dots, of a pale buff tint. These dots are as small as if pricked in with the point of a pin, and are so closely set together as to suggest to a superficial observer the idea of a faint cloudy haze. It often happens, however, that even these minute dots are wholly absent, and the cornea, during an acute attack of iritis, remains perfectly transparent.

There is always a vascular zone in the sclerotic, but not that generally diffused redness of the eyeball so frequently present in rheumatic iritis. Neither, as a rule, is there intolerance of light, which is one of the most marked symptoms of the rheumatic form.

Irides which have naturally a bluish tint, when attacked with syphilitic inflammation, appear more or less green. This is caused by the presence of yellow albumen in the aqueous humour, the admixture of the yellow and blue forming, of course, a green tint. This fact may be demonstrated in some of those old cases

* In Sichel's *Iconographie* (pl. xiii fig. 5), is a good representation of a mass of lymph, reddened with vessels, at the edge of the pupil.

in which chronic iritis has attacked an eye again and again, until sight has been lost, nearly all the tissues having undergone a morbid change. If in such a case the cornea be carefully punctured with a broad needle, and the fluid of the anterior chamber caught in a spoon, the application of heat will at once show the presence of albumen; and if the iris have been originally bluish, that colour will be restored as soon as the last drop of the yellow fluid has drained away from the anterior chamber.

When a patient has syphilitic iritis for the first time, it may attack both eyes together, or may be limited to one eye. When relapses occur, the inflammation usually affects the right and left eye alternately; and these attacks may come on without the patient having contracted any fresh primary disease.

Syphilitic iritis is so much modified by the condition of the patient, that the surgeon must take care not to form to himself any arbitrary idea of the appearances, or expect to find in every case the strongly-marked and unmistakable proofs afforded by large nodules of exudation around the pupil. In fact, iritis may exist to such an extent as to produce serious and permanent obstruction to the pupil, without any development of these nodules. In some cases the lymph is uniformly distributed around the margin of the pupil, which then assumes a thickened ring-like appearance, the rest of the iris exhibiting little, if any, deviation from its healthy aspect. The loss of its mobility, however, is always well marked, even in the slighter cases; and, indeed, the sluggishness or total immobility of the pupil, when exposed to light, is one of the most valuable diagnostic signs of iritis in its early stage.*

Occasionally the nodules of lymph, instead of appearing on the edge of the pupil, are situated on the greater circle of the iris, in the re-entering angle formed between it and the cornea. Such cases are comparatively rare.

In every case of iritis, the surgeon should most carefully examine the area of the pupil, to determine whether it be or be not overspread with lymph. This sometimes exists merely as a very thin film, which may escape detection, unless light be concen-

* I cannot point out any really good representation of iritis in its early stage. Indeed, it is hardly possible for an artist to convey a true notion of the delicate changes in form and colour which characterise the disease at that period.

trated upon it by means of a lens of short focus. Such a film, however, if not speedily removed by proper treatment, will rapidly become thickened by fresh deposits, and, growing more and more opaque week by week, will eventually form a serious obstacle to the transmission of light.

The so-called 'closure of the pupil,' justly regarded as the most serious termination of unchecked iritis, is caused partly by the nodules of lymph which are thrown out upon the margin of the pupil, and unite it to the capsule of the lens (*synechia posterior*), and partly by fluid exudation of the same inflammatory kind, which overspreads that portion of the capsule corresponding to the pupillary area. This exuded fluid, as it solidifies, forms organised connections with the nodular deposits on the edge of the pupil, and eventually, by its contraction, draws the margin of the pupil together, and permanently blocks up its greatly diminished space with a tough, firm, and opaque membrane.*

Treatment.—From what has been said, it will be seen that the leading principle in the treatment of syphilitic iritis consists in procuring as quickly as possible the absorption of the lymph which has been effused in and around the pupil. To effect this, the most powerful agent is *mercury*. But when we consider the variety of constitution in patients attacked with syphilitic iritis, the impaired state of general health they frequently exhibit, in consequence of venereal taint, and the period at which the iritis sometimes occurs—namely, while they are only just recovering from the debilitating effects of salivation—it is evident that, in a treatise like the present, little more can be done than to indicate the outlines of treatment, and that the judgment and tact of the surgeon must be brought to the careful study of each individual case.

When a recent case of syphilitic iritis comes before us in a patient of good general power, we may at once order two grains of calomel, with a third or half a grain of opium, to be taken night and morning; first clearing the bowels, if necessary, by a rapidly-acting aperient. In private practice, where our patients are not necessarily exposed to the weather, the calomel may be given more frequently, but in smaller doses; a grain, for instance, every four hours, combined with just enough opium to prevent purging.

* This form of obstruction is sometimes called 'spurious cataract;' but the term is manifestly improper, as the word 'cataract' should be strictly limited to opacity of the lens itself.

The effect of the mercury must be judged of by the state of the eye, not by the soreness of the gums. Indeed, I look upon soreness of the mouth as a condition to be always avoided, if possible; never to be willingly produced, as is so often the case. As soon, therefore, as the gums begin to be at all affected, the calomel is to be given less frequently; the absorption of the lymph in the pupil being the test of the mercury having been effectual. The two-grain pills may be taken once instead of twice a day; the grain every four hours changed to the same quantity every twelve hours, and then taken at twice that interval of time.

A patient sometimes comes before us with recent iritis, which has come on while he was actually under the influence of mercury, given for venereal disease. What are we to do in such a case? Perhaps we shall find that the patient, while taking the mercury, has been kept on very low diet, deprived of all animal food, and restricted to 'slops.' In that case, the mere change to a better diet—animal food and other nutriment being given, with a moderate quantity of the stimulant to which he has been accustomed—will often effect a surprising change, and stop the further effusion of lymph; while iodide of potassium, with bark, or, if the patient be extremely depressed by the mercury, even quinine alone, will at once cause absorption of the lymph to begin.

Or a directly opposite state of things may exist. The patient may have sought relief from the depressing effects of too much mercury by indulging in stimulants, and in this way may have induced an irritable condition of the circulation, quite incompatible with a due interchange of material in the system. Restriction of stimulants within due bounds will be as essential in this case as their use had been in the case of the ill-nourished and anæmic patient.

If a patient has been attacked with syphilitic iritis while under the depressing influence of too much mercury, given for general syphilis, and it has been found necessary to suspend the use of the mercury until tonics and a change of diet should have improved his general health, we shall often find, that by resuming the mercury in *small* doses, while at the same time we continue the tonics, the iritis will yield, although it may have resisted the large doses which had been given under circumstances of over-stimulation or deficient nutrition.

Turpentine was recommended by Carmichael as a substitute

for mercury, in those cases to which I have alluded as unsuitable for the administration of the latter, on account of general debility. I have, however, found more benefit from the use of iodide of potassium, or even of very small doses of mercury, combined with tonics and improved diet, as above described. I have sometimes found turpentine of service in cases of rheumatic iritis, characterised by hyperæmia of the iris and sclerotic, but unattended with much disposition to effusion of lymph.

Whether the iritis be treated with mercury or not, the pupil is to be kept dilated by means of atropine.

Syphilitic iritis has often a tendency to become *chronic*; each relapse being characterised by a slight sclerotic zone, a yellowness of the aqueous fluid, giving a greenish tint to blue irides, general dimness of sight, and a slight filmy deposit in the area of the pupil. This chronic form is chiefly found in patients who are the subjects of tertiary syphilis, and a carefully-regulated course of iron often affords the best means of treatment.

In describing iritis, I have hitherto spoken only of those changes which are visible under ordinary observation; but the ophthalmoscope has demonstrated to us, what we formerly could only guess at, namely, that in so-called iritis the *retina* is often more seriously affected than even the iris itself.

To attempt to examine the retina during an acute attack of iritis, would be not only useless, but injurious; for the lymph deposited in the pupil, and perhaps in the vitreous humour also, would prevent any clear view of the parts behind; while the glare of light would be almost certain to increase the already existing hyperæmia of the organ. We often, however, have the opportunity of examining the retina after all inflammation has passed away, leaving the cornea, lens, and vitreous humour transparent. We can then fully appreciate the close connection between syphilitic inflammation of the iris and of the retina, and understand why it is, that in cases of so-called 'iritis,' the dimness of vision is often out of all proportion to the changes in and about the iris.

One of the sequelæ of iritis (I use the word 'iritis' in its more extended sense), is a cloudy condition of the vitreous humour, in which filaments and shreds, varying in shape and size, float freely in every direction. These bodies, although really whitish, of course appear black, or nearly so, when seen against

the illuminated retina. They appear to be inflammatory deposits, intermixed in some instances with broken-up hyaloid membrane.

The retina presents still more varied marks of syphilitic inflammation. The optic nerve appears greatly enlarged, irregular in its outline, and of a homogeneous whitish texture. It is probable that in such cases we do not see the real tissue of the optic nerve, but only a layer of lymph overlying it. The vessels emerging from the nerve are small and shrunken. Large, irregular, white patches are scattered over the retina, in some cases involving the greater part of its surface. These appear to be portions of the nervous coat infiltrated with lymph, and no longer permeated by vessels. Patches and dots of black pigment are frequently seen scattered over and among these opaque portions of the retina. (Plate II. fig. 1.)

Hence, it appears that syphilitic inflammation, when it attacks the eye, may exhibit its chief phenomena in the iris, involving the retina only to a very slight extent; or both structures may be equally affected; or lastly, the retina may suffer in such a degree as almost to become useless, while the iris shows little, if any, sign of inflammation, and the patient is hardly aware of the eye being the subject of disease, until vision is found to be almost lost.

SYPHILITIC IRITIS IN INFANTS.

Iritis is one of the rarest forms in which hereditary syphilis manifests itself during infancy. The careful researches of Mr. Hutchinson,* however, have shown that it is not quite so rare as has been supposed; and it probably often escapes notice on account, as he observes, of the very small amount of local symptoms which it causes, coupled with the fact that infants usually keep their eyes shut. Within the last ten years I have seen but five or six cases of syphilitic iritis in infants, among the many thousands of patients whom I have treated at the Moorfields Hospital. Some of these infants presented the stunted and unhealthy aspect which usually accompanies inherited syphilis; but two, whose cases I have elsewhere reported in full,† were well-grown children.

* The result of Mr. Hutchinson's observations is given in *A Clinical Memoir on certain Diseases of the Eye and Ear, consequent on Inherited Syphilis, &c.* 1863.

† *A Guide to the Practical Study of Diseases of the Eye*, 2nd edit. 1859, p. 149.

One of the most striking peculiarities of iritis in infants is the very slight development of a sclerotic zone, that unfailing sign of iritis in the adult. Indeed, in some of the cases I have seen, sclerotic redness could hardly be said to exist.

The infant at the age of from two to ten months is attacked with copper-coloured eruption; perhaps also with mucous tubercles about the genitals, aphthæ in the mouth, and 'snuffles.' The eyelashes fall off, and sometimes the nails also are partially detached. In some cases the skin presents a peculiar dusky tint, and is wrinkled and scurfy.

The lymph does not assume the form of solid tubercular masses on the edge of the pupil, as in the adult, but either fills the area of the pupil, as a pale yellow semi-fluid mass, or sinks down to the bottom of the anterior chamber, like ordinary *hypopyon*. In one of the cases I saw, the lower half of the iris was completely hidden by a nodular mass of lymph, of a pale buff tint, which came into contact with the cornea, and completely filled the anterior chamber as high up as the middle of the pupil.* In another case, the effused lymph—for such it seemed to be—was scattered all over the lower half of the iris in the form of little, greyish-white, semi-transparent granules, like grains of coarse sand. The pupil was fringed with the same kind of deposit.

Treatment.—Before speaking of any special medicines for infants affected with syphilitic iritis, I would remark on the absolute necessity for their being suckled, and not brought up by hand. The milk of a healthy wet-nurse would of course be infinitely preferable to that of an infected mother; but in the lower classes of society, among whom this disease is almost exclusively met with, the services of a wet-nurse can hardly be obtained.

Mercury should at once be given; and as hydr. c. cretâ is very uncertain in its chemical composition, I always make use of calomel, giving from a quarter of a grain to half a grain night and morning. The effect of the medicine must be carefully watched from day to day, and as soon as the lymph begins to disappear from the eye, and the cutaneous eruption to fade, the dose may be gradually diminished; but it will often be necessary for the mercurial

* *Guide to the Practical Study of Diseases of the Eye*, 2nd edit. 1859, p. 149, fig. a.

treatment to be continued, in a modified form, for several weeks. Weakly infants will be much benefited by taking five minims of Battley's liquor cinchonæ twice a-day in a little milk. Provided the child sucks and digests well, the mercury does unmixed good, and, by counteracting the venereal poison, not only frees the skin from the specific eruption, but imparts to it a healthy hue, instead of the peculiar dusky colour which was originally so evident.

A few drops of a solution of atropine containing two grains of the sulphate to an ounce of water, may be put into the eye once a day. So powerful a poison cannot safely be used without limit to young infants, even in its diluted form.

SCROFULOUS IRITIS.

Most of the patients in whom I have observed this form of iritis have been between five and fifteen years of age, and all have shown signs of a scrofulous constitution.

The iritis presented a resemblance to the syphilitic inflammation of adults, in respect of the abundant exudation which took place on the iris, and in the anterior chamber; but in the severer cases of the scrofulous form there was a still greater disposition to enlargement of the veins of the iris, and infiltration of its whole tissue, than is usually met with in syphilitic cases. In scrofulous iritis the large masses of yellow deposit are not so frequently limited to the margin of the pupil, but often appear midway between the pupil and the outer circle of the iris, or at the latter point, just in the angle between the iris and the cornea. Slight bleeding not unfrequently takes place into the anterior chamber, from giving way of the distended veins of the iris.

The cornea usually remains clear, but it sometimes presents a slight degree of mottled opacity, especially towards the lower part.

Treatment.—In the treatment of scrofulous iritis, as in all scrofulous affections, the diet and general mode of life deserve the utmost attention. Abundance—not excess—of animal food; warm clothing; pure air—sea-air, if attainable—are all important adjuncts to the medical treatment. Cod-liver oil is often of great service, and may be taken in combination with the other remedies. The bowels are usually irregular, and the

appetite bad; and a mild aperient will be occasionally required; but care should be taken to avoid drastic purgatives, such as scammony and jalap.

When there is abundant inflammatory exudation into the anterior chamber, without much enlargement of the veins of the iris, or development of a sclerotic zone, half a grain or a grain of calomel at night, and two or three grains of quinine, or ten or twelve minims of liquor cinchonæ, taken an hour or so after a meal, will often produce a rapid absorption of the effused fluid. Where the exudation assumes the solid form, infiltrating a considerable portion of the iris, or appearing at its inner or outer circle as large yellow nodules, reddened with vessels, the iodide of iron is often useful, both in promoting the absorption of the deposit, and in diminishing the vascularity of the iris itself.

All stimulating lotions must be avoided; nor, indeed, except atropine, is any local application of service.

GONORRHEAL AND ARTHRITIC IRITIS.

I have never been able to trace an attack of iritis as a result of simple gonorrhœa; although, of course, it may often happen that a patient is attacked with ordinary rheumatic iritis within a short period of his having had urethral discharge. Gonorrhœa is unfortunately so common, that were there any definite form of iritis dependent upon it, so marked a sequela of the discharge would be constantly brought under our notice.

Neither have I seen cases of iritis which I could refer to gout. The descriptions of 'arthritis iritis' one meets with in books are chiefly taken from German writers, especially Beer and his contemporaries, whose account of the disease, which they term *gouty* inflammation, more nearly answers to that of chronic glaucoma. The ash-coloured ring in the sclerotic, immediately surrounding the cornea, described by German writers as the *arthritis* ring or circle, and regarded by them as diagnostic of arthritis iritis, is not peculiar to any special form of inflammation. Its presence merely depends upon the anatomical arrangement of the adjacent portions of the sclerotic and cornea. When these two structures are united obliquely, so that a considerable extent of the sclerotic is overlapped by the cornea, the vessels of the former do not appear to advance so near to the iris as in other cases; and hence a narrow ring, of a paler tint, is

interposed between the iris and the dense plexus of vessels forming the sclerotic zone.

USE OF ATROPINE IN IRITIS.

In a former edition of this work I spoke unfavourably of the employment of atropine during the acute stage of iritis. Subsequent experience has led me to modify my opinion on this subject. Of course the action of atropine will be most evident in those cases where the inflammation is quite recent, and where consequently the tissue of the iris is not, as yet, much thickened by congestion of its vessels, nor infiltrated with lymph. Where abundant effusion of the latter has taken place around the margin, and within the area of the pupil, atropine may not produce any change visible to the observer; but when this stage of effusion has not yet arrived, or when, at a later period, it is passing off, persistent dilatation of the pupil may be induced by atropine, and such dilatation will have the effect of hindering the formation of adhesions between the iris and the capsule, or of causing such adhesions, if already existing, to give way. In all cases of iritis, therefore, a solution of atropine should be dropped upon the eye night and morning. Where the inflammation is recent, and atropine is used in anticipation of lymphatic effusion, rather than to counteract the solidification of deposits already formed, a solution of two grains of the sulphate of atropia in an ounce of distilled water, may be employed; but in the more acute cases a solution of double that strength will be required.

Not contented with insisting on the utility of atropine as an adjunct to mercury in the treatment of iritis, some recent writers have even gone so far as to recommend that the disease should be treated by the use of atropine alone. More dangerous trifling I cannot conceive. No doubt cases of iritis occur in which the tendency to effusion of lymph can hardly be said to exist at all, and such exceptional cases may possibly get well without any mercury being given. But we are not warranted in assuming that a case of iritis which begins in a mild form is going to maintain that character throughout, and it is our duty to employ that agent which above all others has the property of counteracting the effusion of lymph, and the consequent loss of transparency in parts essential to vision. And what rational cause is there for this anxiety to avoid the employment of

mercury? Used ignorantly, as we too often see it used, mercury is a fearful curse to mankind; but moderately and judiciously used it is one of our greatest blessings. If patients with iritis are to be so impregnated with mercury that profuse salivation and all the other miseries of mercurial poisoning are induced, they may well pause before submitting to a remedy almost as bad as their disease. But this kind of mercurial treatment is never necessary. Those cases of iritis commonly do best where the mouth has not even been made tender, and therefore there is no real necessity for the attempts that are being constantly made to treat iritis without mercury. We are often told that iritis will get well without it—and so no doubt it will, in a certain sense, get well without any treatment at all. But what is meant by ‘getting well?’ A wound gets well when a sufficient deposit of organisable material has taken place between the divided surfaces; and the denser the cicatrix, the more thorough is the cure. Or a case of hydrocele ‘gets well’ when the walls of the sac are thoroughly glued together by abundant inflammatory deposit. But the eye is in one respect a wholly exceptional organ. Once let its transparent tissues become opaque, and then, although the eye may in a certain sense have recovered from an inflammatory attack, the function of the organ is impaired or destroyed. The treatment of iritis consists in speedily preventing the formation of patches or films of inflammatory deposit in the transparent media of the eye, and if mercury has the invaluable property of doing this, it seems criminal in the surgeon to neglect the use of it.*

It is a curious fact that in certain persons the application of sulphate of atropia to the conjunctiva will set up all the symptoms of acute catarrhal ophthalmia. I do not speak of solutions to which a few drops of acid or of alcohol have been added. Such additions, I know, are sometimes made; but they are as unnecessary as they are irritating, for well-made sulphate of atropia is quite soluble in distilled water. The first instance of my meeting with this effect of atropine occurred several years ago, in a hospital in-patient who used drops from the same solution that was being dispensed at the time to many hundreds of others, none of whom experienced any similar inconvenience. As soon as the drops were discon-

* Remarks on the use of atropine in iritis almost identical with the above, were to have been added to the third edition of my *Guide to the Study of Diseases of the Eye*, 1866, but by inadvertence they were not sent to the printer.

tinued, the conjunctival inflammation rapidly subsided, and it was again excited by a reapplication of the atropine. I have recently met with another case, in which great irritation, both of the eye and eyelids, followed the use of drops which I myself applied and knew to be perfectly neutral.

SEQUELÆ OF IRITIS.

Besides the changes already mentioned as resulting from iritis, such as obstruction, or closure of the pupil, the inflammation is sometimes followed by degeneration of structure, which more or less involves the whole tissue of the iris.

Chronic iritis, for instance, in a cachectic subject, especially if the disease has been allowed to run on unchecked, is apt to induce a permanent thickening of the iris, all appearance of its normal fibrous tissue being lost, and the veins of the part becoming enlarged and irregularly dilated.

On the other hand, the constant pressure of a calcified lens, which has become thrust forward against the iris, will sometimes induce such wasting of its tissue, that the uvea wholly disappears, and the thin web of iris which remains allows the chalky-white lens to be distinctly seen through it.

Another consequence of iritis is the distension of the iris into *pouches*, which are formed in the following way. An attack of syphilitic iritis, left to itself, or badly treated, causes the whole margin of the iris to adhere to the capsule of the lens; the pupillary area being, at the same time, very small, and filled up with opaque deposit. All communication between the anterior and the posterior aqueous chamber is cut off; and the aqueous fluid secreted in the latter cavity, not being able to pass through the pupil into the anterior chamber, accumulates behind the iris, and gradually distends and presses it forwards; the pupillary margin meantime being prevented from advancing with the rest of the iris in consequence of its union with the capsule.

If the uveal surface, except just at the edge of the pupil, be free from adhesion, the whole anterior surface of the iris forms one convex mass, with a deep depression at its centre, in the position of the closed pupil; but if the uvea be here and there adherent to the capsule of the lens, the iris at those spots remains retracted, like the pupil, while intervening portions of iris are thrown into a series of pouches which may almost, or quite,

touch the cornea. These pouched portions of iris lose their fibrous appearance, and have a dark slaty tint.

Vision, in such cases, is reduced to mere perception of light ; but, provided the retina be sound, excellent sight can often be restored by means of a carefully-planned and skilfully-executed artificial pupil.

In cases of long-continued iritis, combined with disease of the choroid, and of the anterior portion of the sclerotic, the iris not only becomes united to the capsule, and bulges forwards in the manner just described, but the fluid secreted in the posterior aqueous chamber, continuing to accumulate, exerts pressure on the anterior portion of the sclerotic, and stretches its weakened tissue. This gradually yields, and forms a *staphyloma scleroticæ*, a tense bluish-black prominence, streaked with the widely-separated whitish lines of the sclerotic fibres. At first, while the prominence is small, it is usually situated at the upper part of the globe, just behind the cornea ; but the distension may go on until the whole of the sclerotic, between the line of insertion of the recti muscles and the margin of the cornea, forms one bulging lead-coloured swelling. *Staphyloma scleroticæ* is always a sign of the deeper tissues of the eye having suffered from disease, and, if developed to any considerable extent, would contra-indicate operations for artificial pupil or cataract.

Cysts of the iris.—In very rare cases a punctured wound of the iris, near its ciliary attachment, has been followed by a cyst-like expansion of its substance, in consequence, apparently, of the fluid of the posterior aqueous chamber finding its way between the uvea and the fibrous tissue of the iris.

These cysts present a dark slaty tint, which nearly approaches to black when their walls become very thin. The treatment of these cases is often extremely troublesome, on account of the readiness with which the expanded iris-tissue reunites after being lacerated. When the lens is *in situ*, and transparent, the difficulty is greatly increased.*

OPERATIONS ON THE IRIS FOR ARTIFICIAL PUPIL.

Many of the diseases and injuries affecting the iris and cornea described in the foregoing chapters, produce complete closure of

* See a case reported at length in my *Guide to the Study of Diseases of the Eye*, 2nd edit. 1859, p. 408.

the pupil, while others either cause it to become displaced from its natural position, or leave it more or less completely hidden behind a dense corneal opacity.

All operations for the relief of such obstructions or malpositions of the pupil may be suitably described in this place; while the operation on the iris, for the cure of *glaucoma*, must be deferred until that disease has been considered.

The term *Artificial Pupil* must be understood to include not only the formation of a new aperture in the iris, when the portion forming the natural pupil has prolapsed through a breach in the cornea, but also the reopening or the enlargement of the natural pupil when obstructed by inflammatory deposit; or the displacement, towards a transparent part of the cornea, of a pupil which has become overshadowed and hidden behind a dense corneal opacity.

Before attempting any form of operation for artificial pupil, the surgeon must make himself thoroughly acquainted with the history of the case, and especially ascertain for himself the following conditions:

First, whether the eye perceives light: mere obliteration of pupil will not deprive the eye of this power, provided the retina be sound; for we know, by personal experiment, that even the thickness of our closed lids does not prevent our noticing the shadow of a hand passing between our eye and the window.

Secondly, the presence or absence of the lens must, as far as possible, be ascertained, and, if present, whether it is transparent or opaque.

Thirdly, the cornea must be carefully examined, as to its degree of transparency.

Fourthly, the state of the iris itself must be noticed. The existence of chronic iritis would induce the surgeon to defer the operation until the inflammation had ceased. A thickened iris, in which all trace of its peculiar fibrous structure is lost, is specially unfitted for an operation, as it breaks away under the slightest traction, and, if cut, the wound does not gape, so as to form a permanent aperture.

As a rule, it is not desirable to operate for artificial pupil when the other eye is perfect.

The principle, not to inflict unnecessary injury on the parts operated upon, which holds good of every surgical operation, applies with peculiar force to that for an artificial pupil; for often the portion of transparent cornea is very small, and a

needlessly large cicatrix may seriously diminish the patient's field of vision.

Generally speaking, a small artificial pupil is more useful than a large one; that is to say, if it can be made in such a position that all the cornea in front of it is transparent. Sometimes, however, the pupil has to be drawn from behind an opaque corneal cicatrix; and in that case it is only by making a large aperture that a sufficient portion of it can be rendered available.

Inasmuch as the natural pupil is placed nearly in the centre of the iris, it would follow that a similar position must be the most suitable for an artificial aperture. Various considerations, however, may induce the surgeon to select a more peripheral situation; but he should always strive to approach the centre of the iris, as far as circumstances will allow.

Peculiar care is required in the examination of those cases, frequently brought under our notice, in which the greater part of the cornea appears converted into a more or less prominent, densely opaque, white cicatrix, after severe purulent or gonorrhœal ophthalmia. The patient may have good perception of light, and there may be an appearance of a narrow strip of semi-transparent cornea adjacent to the sclerotic, suggesting the possibility of an artificial pupil being made. And yet the appearance of true corneal tissue may be altogether deceptive.

When the whole cornea has been destroyed by ulceration, as in severe purulent ophthalmia of infants, or the gonorrhœal ophthalmia of adults, the iris is for a time laid bare; but very soon exudation takes place on its surface, while the iris, yielding to the pressure behind, gradually forms the prominence known as *staphyloma*. The greater part of this fibrinous coating of the iris eventually becomes white and opaque, and traversed by ramifying vessels; but the marginal portion of the iris is covered by a semi-transparent tissue, united, perhaps, to a very narrow ring of true cornea, just that portion immediately connected with the sclerotic. No space, however, exists between this semi-transparent, cornea-like tissue, and the fibres of the iris; and any attempt, therefore, to make an artificial pupil in this situation would only end in disappointment.

The different modes of making an artificial pupil may be classed under four heads: *laceration*, *incision*, *excision*, and *ligature*.

tion of the iris from its ciliary attachment, and is so unscientific, clumsy, and ineffectual an operation, that I should not even mention it, were it not sanctioned and recommended by many continental authorities in ophthalmic surgery. Near the margin of the cornea an incision is made, through which a sharp hook is introduced, and then carried across to the opposite side of the anterior chamber. Here the hook is stuck into the iris, and then drawn back towards the corneal wound. This traction causes the ciliary attachment of the iris to give way; and when the iris has been separated to the extent desired, the hook is detached and withdrawn from the eye.

An artificial pupil of this kind involves almost all the faults it is possible to include in one operation. Its position, opposite to the margin of the cornea, is the worst that could possibly be chosen; the size of the rent cannot be accurately limited; the vessels and nerves of the iris are torn just where they are largest; the great circular vein, surrounding the iris, pours out a quantity of blood, which partly or wholly fills the anterior chamber, and is not readily absorbed; if the lens be present, there is considerable risk of wounding it with the hook, which, in its withdrawal, is frequently caught in the corneal incision. It is to be hoped that this operation, if not already obsolete, will speedily be consigned to the limbo of exploded surgery.

2. *Incision*.—This is the oldest form of operation for artificial pupil, being that employed by Cheselden in a case commonly spoken of as the first in which an artificial pupil was made. The operation is founded on the elasticity of the fibres of the iris, which causes them to retract when cut across, so as to leave an aperture for the transmission of light to the retina. Hence it will be seen that the operation is likely to succeed in proportion to the state of tension and retractile power of the iris, and will be inadmissible in those cases of closure of the pupil resulting from chronic iritis, or any other disease of the iris which has caused softening and degeneration of its tissue. The operation by incision would also be contra-indicated if the lens were present, as injury to it must almost inevitably follow the penetration of the iris by a cutting instrument.

The operation, therefore, is much restricted in its application, and is almost confined to those cases in which, after extraction of a cataract, there has been prolapsus iridis to such an extent as wholly to obliterate the pupil, the fibres of the iris remaining

healed into, and confounded with, the corneal cicatrix.

The incision is made either with a cutting-needle or a fine narrow knife, or else with scissors. The needle or knife is passed into the anterior chamber close to the edge of the cornea, and when the point has been carried a little beyond the middle of the iris, the cutting edge is turned backwards, the point is made to penetrate the iris, and its fibres are divided to such an extent as may be desired. The needle or knife is then rotated into its original position and withdrawn.

Maunoir * modified the operation by using scissors for dividing the iris; but of course they required a large corneal wound for their introduction, and neither the linear nor the V-shaped incision which he recommended was found by any means easy to accomplish when the iris had become flaccid after the escape of all the aqueous humour. If scissors are employed at all, the cannula-scissors, invented by Wilde, would be found far more convenient for incising the iris, as they may be so constructed as to cut their own way into the cornea, and fill up the wound they make, thus retaining a good deal of the aqueous humour.

In cases where a very narrow strip of cornea alone remains transparent, after sloughing or ulceration throughout the rest of its extent, it becomes of the utmost importance to accomplish the division of the iris with as little injury to the cornea as possible. In such cases I have found the most useful instrument to be a broad needle, cutting on both sides for a short distance from its point.

3. *Excision*.—In cases where the pupil had become drawn together, and its contracted area blocked up with an opaque membrane, in consequence of iritis, the lens being unaffected, the operation of incision, either by the knife or scissors, was contra-indicated, since it was hardly possible to puncture the iris with a cutting instrument without wounding the lens. The operation of excision therefore became necessary, which was performed as follows: an opening of sufficient size having been made in the cornea, a forceps was introduced into the anterior chamber; its branches were then opened, a portion of iris was included between them, and, being grasped, was drawn out of the corneal wound, and cut off with scissors. The objection to

* *Mémoires sur l'Organisation de l'Iris et l'Opération de la Pupille artificielle*, Paris, 1812.

removed; the pupil was usually very large, and extended almost, if not quite, up to the border of the cornea.

The 'blunt hook,' invented by Tyrrell, introduced a more delicate and precise mode of operating; and, for special cases, has not been superseded by any subsequent contrivance. It requires only a very small corneal wound for its introduction; and it can be employed without risk in cases where the lens is *in situ* and transparent.

It is specially adapted for the following cases. First, when, after extraction, there has been extensive prolapse of the iris, so as to obliterate all but a very small vestige of the pupil. Secondly, when, in consequence of iritis, the whole pupillary margin has become adherent to the capsule, the peripheral portion of the lens itself remaining transparent. And, lastly, when the iris is perfectly healthy, but the pupil is hidden behind a dense central opacity of the cornea, the rest of the cornea remaining clear.

a. In a case such as I have alluded to under the first head, we will assume the lens to have been extracted through an upward section of the cornea. The artificial enlargement of the pupil would be made in the following manner: the lids being held apart with a spring-wire speculum, the surgeon steadies the globe by nipping up with a forceps a little fold of the ocular conjunctiva, just above the upper edge of the cornea; he holds in the other hand the broad cutting-needle, which he passes through the lower edge of the cornea, close to its junction with the sclerotic. If the width of the blade be properly proportioned to the size of the hook, a simple puncture will suffice; but if the needle be narrow, its edges may be used to enlarge the wound to a sufficient extent. The needle should now be gently withdrawn; not with a jerk, as such a movement is usually followed by a spurt of aqueous humour, and it is important to retain as much of that fluid as possible. The surgeon then takes the blunt hook, and passes it in through the corneal wound, the flat side of the hook coming in contact with the iris. The instrument, held in this position, is rapidly passed upwards, until its extremity reaches the small pupillary opening; then the handle is rotated so as to allow of the lower edge of the displaced pupil being firmly caught in the bend of the hook; gentle traction is then made, and at the same time the handle is again rotated in such a manner that the short bent portion faces directly

drawn through the corneal wound without catching in it; and it is for the want of attending to this little manœuvre that those who use the blunt hook so frequently find a difficulty in withdrawing it. When the hook, holding the iris, has been fairly brought out of the wound, an assistant, with a pair of fine scissors, snips through the iris, close to the hook, if a good portion of iris has been secured; but should the iris have torn, and only a small portion been withdrawn, it may be desirable to cut through it close to the cornea. Sometimes the tissue of the iris is so much softened that it breaks in coming out, and then the surgeon must use a fine forceps to catch what remains, and so prevent its retracting into the anterior chamber.

Any little shreds of iris that hang in the wound should be returned by means of a little spatula, so that the lips of the wound may come into exact apposition.

The description just given of the mode of using the blunt hook, and of other details in the operation for artificial pupil, will apply to the different modifications subsequently described. The wire speculum, and forceps to steady the globe, will always be found useful, often indispensable. The patient should lie down on a couch; and the best light is usually obtained by the foot of the couch being turned towards the window; the surgeon standing or sitting behind the patient's head. The use of chloroform will be regulated by circumstances; it is commonly necessary with children, or very intractable patients; but the pain of the operation, when skilfully performed, is so trifling, that patients possessed of self-control can usually dispense with chloroform altogether.

b. The next class of cases in which the blunt hook should be employed is that where iritis has terminated in adhesion between the whole or the greater part of the pupillary margin and the capsule of the lens.

At p. 113, under the head 'Sequelæ of Iritis,' I have described such a condition of closed pupil, accompanied by a bulging forward of the iris, in consequence of the pressure of the fluid secreted in the posterior chamber of the aqueous humour. When the whole surface of the uvea has become adherent to the capsule of the lens, these pouch-like dilatations of the iris do not exist. When only the extreme edge of the pupil adheres, the rest of the uveal surface remaining free, the contracted pupillary area, blocked up with opaque membrane, remains

fixed, while the iris bulges all round it, so as in some places to touch the cornea. Partial adhesions of the uvea to the capsule give rise to deep grooves, subdividing the iris into separate pouches; the accumulation of fluid behind the iris being unable at these points to thrust it forwards.

When the whole cornea is clear, and the surgeon can select the position in which to make an artificial pupil, he will find it best to extend it either directly outwards, or directly downwards; and in a case of pouched iris, such as I am now considering, if a depression in the iris exists in either of these directions, he may take advantage of the circumstance to insinuate the cutting-needle and hook between the cornea and iris, without risk of wounding the latter.

When, however, he has succeeded in catching the edge of the pupil, and drawing out a piece of iris, he may perhaps be disappointed to find that he has removed only its fibrous portion, and that the aperture he has made is still blocked up by a layer of uveal pigment, adherent to the anterior capsule. Although in such a case the first operation may have done but little towards restoring sight to the patient, it will be found to have greatly facilitated a second operation, as the fluid which had been pent up in the posterior aqueous chamber can now find its way into the anterior chamber, and, in consequence, the whole iris will lose its pouched appearance, and recede from the cornea. When the slight irritation caused by the first operation has passed off, the cutting-needle may be introduced at a new point of the cornea, the edge of the artificial pupil caught with the blunt hook, and drawn in such a direction as to remove a portion of iris which had never been adherent to the capsule. If the periphery of the lens be transparent, this second operation will at once open a way for the rays of light to pass to the retina.

c. Extensive ulceration at the centre of the cornea, stopping short of actual perforation, may leave a cicatrix so large and opaque as entirely to cover the pupil, restricting the patient's sight to the perception of large objects placed very much out of the line of direct vision. The iris itself, when viewed through the transparent periphery of the cornea, may present a perfectly healthy appearance, and there may be every reason to suppose that the whole globe, with the exception of the cornea, has been unaffected by disease. In such a case, the object of the surgeon will be to displace the pupil either outwards or downwards,

accordingly as he finds the outer or the lower portion of the cornea preferable in respect of transparency. The blunt hook is the most convenient instrument for effecting this displacement, as it does not endanger the lens, which I am supposing to be perfectly healthy. An opening having been made, either at the outer or lower margin of the cornea, in the manner described at p. 119, the free margin of the pupil is to be caught with the hook and drawn out, a larger or smaller piece of iris being cut off according to the size of the corneal opacity beyond which the pupil is to extend.

4. *Ligature*.—In spite of every precaution, it is not always possible to limit the size of the pupil, which sometimes opens out to an extent greater than was originally intended. To remedy this inconvenience, Critchett suggested an operation which he termed ‘Iridodesis,’* and which is applicable to a limited number of other cases of artificial pupil besides that just described; as, for instance, where prolapsus iridis has occurred, and so much of the pupillary margin has been drawn into the cicatrix as to reduce the area of the pupil to a very minute aperture; or where the whole pupil has been displaced towards the extreme edge of the cornea, and there overshadowed by an opacity. A puncture is made through the cornea sufficient for the introduction of a cannula-forceps; a small portion of the iris near its ciliary attachment is grasped, drawn out through the wound, and tied there with a very fine silken thread. This transforms the pupil into an elongated slit. Should this aperture be found insufficient, it may afterwards be enlarged by tying a second portion of iris in such a position as to draw the pupil into a triangular form.

The operation by *ligature* has the advantage of leaving the margin of the pupil uninjured; and in some cases it has been found that even a certain amount of dilatation and contraction of the aperture has been maintained.

It is far from my intention, in treating of ophthalmic surgery, to attempt a record of all the schemes that have been suggested or put in practice. To describe the operations and instruments which artificial pupil alone has called forth, would be to enumerate a long and tedious catalogue of inventions, most of which have been long since abandoned as useless.

* *Iridodesis* or *Iridodosis* would be a more correct word to imply tying (ἑλκε) of the iris, inasmuch as the genitive of ἱρίς is ἱριος or ἱριδος.

After-treatment of an artificial pupil.—The various forms of operation I have recommended in the foregoing pages, if skillfully performed, inflict so little injury on the eye, that, provided the parts be in a fit state to undergo the operation—all inflammation being extinct, and the patient's general health having been properly attended to—little more than repose of the eye is required to enable the cornea to heal; and when that is effected, the wounded iris soon regains its natural texture and appearance. We are often, however, obliged to operate on an iris which has undergone long-continued and repeated attacks of inflammation. The tissue of such an iris is soft and spongy, and its enlarged vessels, when torn or cut, pour out their blood into the anterior chamber, where it may remain for many weeks, or even months, without being absorbed. On the contrary, when the iris is sound, and the patient's health good, but little blood is effused into the anterior chamber, and that little commonly undergoes absorption in the course of a few days.

After an operation for artificial pupil, *both* eyes should be lightly bandaged, or the lids closed with strips of plaster. On the second or third day the eye may be examined. Should there be much sclerotic redness, or intolerance of light, the operated eye must be again closed for a day or two. In most cases, at the end of a week from the operation, a large eyeshade will be sufficient; but the patient must be warned against too soon exposing the eye to strong light; and if the case be one in which the patient has for several years been limited to perception of light, he must be forbidden to strain his newly-regained powers of sight by premature examination of small objects. A pair of tinted glasses should be worn for some time after he has begun to go out of doors.

If the operation has been performed under chloroform, it will not be advisable to give any opiate or narcotic at night; but in excitable patients, who have not taken chloroform, it is sometimes necessary to give some mild narcotic. From twenty-five or thirty minims to a drachm of tinct. hyoscyami, in camphor-mixture, is what I usually order as a night-draught for an adult who has not been habitually addicted to the use of opiates. But many patients do not require anything of the kind. There is no reason for denying the patient a moderate quantity of plain animal food on the day of the operation, as well as on the following days. Nor should stimulants be wholly forbidden to those who are accustomed to their daily use. I need hardly

say that a patient who is to spend the first day after the operation in bed, and perhaps the rest of the week in the house, is not to live as freely, and have the same amount of stimulants, as if he were taking daily exercise, and were engaged in active pursuits. But, on the other hand, it is absurd to keep a patient on low diet, and deprived of all accustomed stimulants, because a small puncture has been made in his cornea, and a little bit of his iris removed. Old and feeble persons cannot bear such reduction; and if any considerable quantity of blood has escaped into the anterior chamber, the best way to hasten its absorption is to keep the patient's powers up to a healthy standard, by plain nutritious diet, and just such an amount of stimulants as will maintain the circulation at a proper point of vigour.

It is difficult to conceive how surgeons who wrote and practised within the last forty years, could have thought it necessary to resort to the depleting and starving treatment we find them recommending as necessary, after the operation for an artificial pupil. Little more than forty years ago, the late Mr. Guthrie,* in a work professing to teach the operative surgery of the eye, wrote as follows: 'As a general rule, the patient should be *bled largely after any of the operations* for the formation of an artificial pupil;' and he goes on to say, that this bleeding is to be to the extent of fourteen ounces, in some instances to twenty-four, or from that to thirty ounces; that if the diminution of pain be only temporary, and after a few hours begins to increase [which, in an irritable or neuralgic patient, it would be quite sure to do, after all this loss of blood], recourse must again be had to bleeding; and that if *this* should not be sufficient to arrest the progress of the disease, it must be immediately treated as a case of iritis, and mercury administered in such a manner as to affect the system as rapidly as possible.

Such was the treatment by which a simple, delicate, and almost painless operation was perverted into a cause of suffering and misery.

* *Lectures on the Operative Surgery of the Eye*, 2nd edit. 1827, p. 510.

CHAPTER VII.

DISEASES OF THE CHOROID AND RETINA.

(*Amaurosis—Amblyopia—Impaired Vision—Hebetudo Visus—Choroiditis—Retinitis.*)

THE synonyms at the head of this chapter—and their number might be greatly multiplied by quoting from the older writers on eye-diseases—will at once show the difficulty that has always existed in assigning definite terms to those defects of sight which depend upon diseased states of the choroid and retina.

While some writers have classified these diseases *subjectively*, as they are evidenced to the patient by his own perceptions, and have spoken of ‘impaired vision,’ ‘amblyopia,’ and ‘amaurosis,’ others have attempted an anatomical arrangement, which before the invention of the ophthalmoscope was purely speculative and arbitrary, and have assumed inflammation of the choroid or retina to be the material *objective* cause of the phenomena.

The ophthalmoscope has already dissipated much of the mystery which formerly surrounded the deeper tissues of the globe, and has enabled us to demonstrate morbid changes, the very existence of which could only be vaguely suspected before the ophthalmoscope was invented. But when we remember how considerable a portion of the visual apparatus is contained within the cranial cavity, there must always remain a large class of defects of sight, which, like other cerebral diseases, can admit only of a theoretical and uncertain diagnosis.

Choroiditis.—Of course a structure like the choroid, almost wholly composed of a mass of blood-vessels, cannot fail to play an important part in all hyperæmic conditions of the eyeball. But that choroiditis, as a separate and independent disease, can be distinguished by such well-defined symptoms as are described in the older ophthalmic works, is disproved by the revelations of the ophthalmoscope. Patients are daily to be met with who have long suffered from defective sight, in degrees varying from a state in which it is difficult to read or to distinguish minute objects, up to that condition of dimness in which merely the form of large objects can be faintly discerned: to ordinary observation the eyes may appear quite sound, the pupils being

active, and every tissue presenting the aspect of perfect health; and yet the ophthalmoscope may at once reveal morbid changes, which could only have been produced by extensive and long-continued disease of the choroid, portions of this structure having undergone atrophy to such an extent as wholly to have disappeared, leaving the sclerotic exposed to view; masses of pigmentous deposit overspreading the greater part of the choroidal surface, or effusion of serum having occurred in such quantity as to have detached a considerable portion of the retina from its position.

Retinitis.—As with the choroid, so it has fared with the retina, in respect of its supposed diseases and their symptoms. In the older ophthalmic works precise and distinctive descriptions are given of the symptoms of retinitis, which we now know to be altogether fanciful and imaginary. One of the most extensive forms of retinal inflammation, that originating in syphilis, is proved by the ophthalmoscope to be a not unfrequent associate of the disease which still retains the restricted name of ‘iritis;’ and yet, while this syphilitic inflammation of the retina is going on, there are none of the symptoms of retinitis, as formerly described by ophthalmic writers.

In patients who have long experienced impairment of vision, terminating in total loss of perception of light, the ophthalmoscope not unfrequently exposes to our view an amount of deposit on the retina, both opaque and pigmentous, such as could only have resulted from active inflammation; and yet, the progressive failure of sight has been painless, and quite unattended by any symptoms analogous to those formerly received as indicating retinitis.

If it be said that these are instances of *chronic* inflammation, and that the *acute* form must certainly be attended with all the phenomena of hyperæsthesia of the retina, the ophthalmoscope again contradicts the old opinions. Cases occur in which a sudden cloud appears to come before one eye, shrouding all objects in a dense mist, or wholly destroying the perceptive power of a large portion of the retina. No pain whatever occurs in the eye, nor is the patient sensible of any luminous appearances; while the iris and all superficial parts remain perfectly unchanged. Let the pupil be dilated, and the ophthalmoscope applied, and the greater part of the retina will be seen overspread with blood, poured out from some ruptured retinal vessel; and yet the hyperæmia, which must have preceded such

rupture, may have been unattended with any subjective sensations of light.

In fact, the terms *retinitis* and *choroiditis* originated in a desire to apply a precise and anatomical nomenclature to morbid conditions altogether obscure. Before the invention of the ophthalmoscope, this nomenclature passed unchallenged; for neither the active disease, nor the morbid changes resulting from it, could be investigated in such a manner as positively to prove or disprove the surgeon's diagnosis; and he pronounced a case to be choroiditis or retinitis, according to the preconceived notion he might have formed as to the effects which such inflammations would produce on vision.

The term 'amaurosis,' which but a few years ago formed a heading to the longest chapter in every work on eye-diseases, and a title to many an elaborate monograph, must now be consigned to oblivion; unless it be retained to designate those conditions of dim or lost sight the causes of which, being within the cranial cavity, are therefore beyond the range of actual inspection.

Morbid Appearances of the Retina, Optic Nerve, and Choroid.

Any verbal description of the various changes in the deep tissues of the eye, which the ophthalmoscope exhibits to our view, must of necessity be very imperfect; such a description may, indeed, recal to memory peculiarities of form and colour which have already been studied in the living subject; but to the beginner it can suggest only a faint and shadowy picture. In many instances, too, we must content ourselves with describing appearances, the real nature of which we are at present unable to explain.

Retina and optic nerve.—In old persons, whose dimness of sight would suggest the existence of commencing cataract, we occasionally find a *white patch* of variable extent, and very irregular outline, immediately surrounding the optic nerve. Sometimes this patch is of such extent as to encroach upon that portion of the retina corresponding to the axis of vision. These patches are of an opaque dead white, and are quite devoid of vessels. They seem to be due to chronic hardening and condensation of the nervous tissue, with obliteration of the vessels. In some instances, perhaps, fatty degeneration may also be present.

In several cases of Bright's disease, accompanied with great dimness of sight, yellowish-white spots have been seen scattered over the surface of the retina. I am acquainted with only one case in which the fatty nature of these deposits has been proved by dissection.*

The changes in the retina and optic nerve consequent upon syphilitic inflammation have been already noticed in the section on iritis (p. 107).

A very remarkable appearance connected with the optic nerve in myopic persons, consists in a white patch, of a crescentic shape, so immediately in contact with the margin of the nerve as to seem at first sight to form part of the nervous tissue itself. The nerve in these cases is always found to deviate from its normal circular form, and to assume more or less that of an oval, in contact with the narrow diameter of which the white patch is found. As a rule it is placed to the outer side of the optic nerve, but it may be found above, below, or to the inner side. This crescentic patch has been described by German writers under the name of 'staphyloma scleroticæ posticum,' from a supposition that there is always at this spot an actual protrusion of the sclerotic.† This does not appear, however, to be invariably the case.

In an eye which presented the crescentic patch in a very marked degree, it was found on dissection that the pigment-cells of the choroid were altogether wanting throughout the whole extent of the crescent; so that the light from the ophthalmoscope, passing through the transparent retina and wasted

* The case is reported by Heymann, in the *Archiv für Ophthalmologie*, vol. ii. p. 139, 1856. During the progress of the disease the patient became maniacal, so that the ophthalmoscopic examination was difficult. The loss of sight was almost total in both eyes. The media were clear, and an irregular yellowish-white patch was observed just below the optic nerve. Both eyes were examined after death, and presented nearly similar appearances. At a distance of a line or two from the optic nerve, about twenty yellowish-white spots, of various sizes, were arranged in an irregularly circular figure. The largest spot which had been seen during life was situated below the optic nerve, and about a millimetre in diameter. A microscopical examination of the spots, proved them to be isolated portions of fatty degeneration in the ganglionic structure of the retina.

† E. Jæger, *Beiträge zur Pathologie des Auges*, 1853, plate. xvii. A representation is here given of a well-marked crescent, fringed with pigmentous deposit, which was observed in a very short-sighted patient. Plate xviii. shows a still larger crescent, in a case of more advanced myopia. This figure also exhibits the choroidal vessels with that extreme distinctness which is caused by absence of the hexagonal pigment.

choroid, was reflected from the sclerotic itself, which at this point was thinner than natural, but not at all prominent or staphylomatous.*

Among the more striking appearances under the ophthalmoscope are the irregular deposits of *black pigment* on the illuminated field of the retina. These pigmentous deposits present endless varieties as to quantity and mode of arrangement. In one case two or three minute isolated dots may alone be visible; in another case the pigment may assume the form of fine threads, ramifying over a considerable portion of the retinal surface; while, in a third case, the pigment may be aggregated in large black masses, the intervening portions of retina being of healthy appearance. (Plate II. fig. 2.)

Pigmentous deposits are met with at all ages, and generally appear to be a sequel of chronic inflammation, although it very often happens that the patient can give no account of such an attack. Pigment is also commonly seen interspersed in large quantities among the white patches which result from syphilitic disease of the retina.

When a vessel, in either the choroid or the deeper portion of the retina, has given way, and broken up the tissues immediately surrounding the extravasation, absorption of these tissues, as well as of the blood, may subsequently take place to such an extent as to lay bare the sclerotic. A rounded white patch is thus produced, which is usually fringed with a black edge of pigment. In other cases the whole site of the extravasation becomes covered with pigment, so that, instead of a black ring, an irregular black disk is the result. I have met with several instances in which a fringed or blackened patch of this kind was situated directly in the axis of vision. Sight was very imperfect, and limited to a very small space; so that, in the attempt to read a large type, only a single word, or part of a word, could be taken in at a glance.

Extravasations of blood, either from the retina or the choroid, constitute, I need hardly say, the most serious accidents to which those tissues are liable. The blood may be effused in

* See a plate in the first volume of the *Ophthalmic Hospital Reports*, figs. 4 and 5. The nerve in both these figures is over-coloured, so as to present too marked a contrast to the whiteness of the crescent. The dissection by Dr. Bader, alluded to above, will be found at p. 117 of the volume just quoted. Good representations of the myopic patch in various forms are depicted in tab. iii. of Liebreich's *Atlas*.

consequence of a blow on the eyeball, or it may escape spontaneously from a distended vessel giving way, as in ordinary apoplexy.

It is remarkable that rupture of a retinal vessel sometimes occurs without any of the symptoms which one might expect would accompany it—such as giddiness and other signs of cerebral disturbance. I have seen many cases in which a dimness or cloudiness has suddenly overspread one eye, while the patient, in apparently good health, was quietly engaged in reading or writing; no pain or uneasiness of any kind accompanying the attack, the iris retaining its mobility, and even the conjunctiva and sclerotic showing no trace of increased vascularity. The patient finds that a considerable portion of his field of vision has become a total blank as regards perception of objects; while, perhaps, he still retains the power of dimly discerning those which happen to fall on some limited portion of the retina. If such a case is examined within a few hours, or even a few days after the rupture of the vessel, the fresh red colour of the effused blood will at once be recognised. If it is one of the radiating vessels of the retina that has given way, the prognosis will be much more favourable than if the hæmorrhage had come from the choroid; for, in the former case, the tissue of the retina, although for a time overspread with blood, and so rendered incapable of receiving visual impressions, may have escaped any serious disintegration; whereas, if the blood has proceeded from the choroid, it may have actually ruptured the retina, and irreparably destroyed that portion of it as far as its function is concerned. The presence of clots freely floating in the vitreous humour would be a still more unfavourable sign, as it would prove that the tissue of the vitreous body had, to a certain extent, been broken up. This latter complication more frequently results from blows on the eyeball than from spontaneous apoplectic extravasation.

No one who has had a little practice with the ophthalmoscope can find any difficulty in detecting a recent extravasation of blood on the surface of the retina; but the recognition of the changes which mark the site of old extravasations is often extremely difficult. I have already noticed the cases in which a rupture of choroidal vessels breaks up and destroys a limited portion both of the choroid and retina, leaving either a well-defined space of white sclerotic, or a patch of dark pigment, to mark the site of the disruption. But a less extensive extrava-

sation, originating in the rupture of a superficial vessel of the retina, may leave such faint traces as almost to escape observation. Sometimes the site of the rupture is marked by a slight brownish stain, in other cases by a faint mottling of the retinal surface ; while a more extensive extravasation may so far damage the retina as to leave in after-years a linear or stellated cicatrix (if one may so term it), of a lighter colour than the surrounding tissue.

Serous effusion between retina and choroid.—This effusion may occur as a result either of acute or chronic inflammation ; *chronic* effusion between the retina and choroid may take place in the most gradual and insidious manner, so as only to manifest itself by impairment of vision, unattended with any pain or external signs of inflammation.

When the retina has become detached to a very considerable extent, a corresponding portion of the field of vision becomes a total blank so far as perception of objects is concerned ; while that portion of the retina which remains in apposition with the choroid may still distinguish even small objects, although in an imperfect and partial manner.

There are no external signs by which we can ascertain the existence of effusion beneath the retina. The ophthalmoscope alone enables us to detect it.

The effused fluid may either exist in such a small quantity as barely suffices to impart a cloudy appearance to a limited portion of the retina ; or it may have detached a considerable extent of the retina, or even the whole of it, from its connection with the choroid.

The more limited effusions frequently occur in the immediate neighbourhood of the optic nerve. At first sight they appear as greyish or cloudy patches in the midst of healthy tissue, and the radiating vessels which are spread out over the rest of the fundus of the eye appear to be lost when they arrive at the edge of the patch. This appearance is owing to the fact of the vessels being raised up by the effusion beneath them, so that they are on a plane different from that of the vessels of the healthy retina. A slight movement of the convex glass, which the ophthalmoscopic observer is employing, will at once bring into focus the vessels overlying the effusion.

When a large portion of the retina has been separated, it presents the appearance of a lobular mass, of an opaque greyish colour, contrasting in a remarkable manner with the reddish

surface of that part of the retina which still retains its natural position. Sometimes the lobular mass may be observed to oscillate with each movement of the eye; and when brought into focus the surface of the mass is seen to be overspread with ramifying vessels, the displaced veins of the retina.

When almost the entire retina is detached from the choroid, the appearances under the ophthalmoscope are at first very difficult to understand. The whole fundus of the eye appears at one moment of a dull grey, as if covered with a milky gelatinous deposit; then the white disk of the optic nerve comes for an instant into view, and then again a sudden turn of the eyeball affords a glimpse of some very limited portion of undisplaced retina, which still dimly reflects the luminous rays which fall upon it. Not unfrequently the view of the fundus is still farther confused by floating bodies dispersed through the vitreous humour.*

Coloboma of the choroid.—This very curious congenital malformation is associated with coloboma iridis (p. 92), and it presents under the ophthalmoscope a most remarkable appearance. The optic nerve is with difficulty distinguished, as it is in the midst of a large, oblong patch of white, across which some long scattered vessels are seen to ramify. This white patch is the sclerotic, exposed to view by the great gap in the choroid. The sheath of the optic nerve is also said to be imperfect in these cases.†

Optic nerve.—I have already described the appearance of this nerve in health, and have incidentally noticed a few of its morbid changes, such as are found in connection with myopia, and with syphilitic inflammation of the iris.

Very great variations in the form and colour of the nerve are compatible with good sight. As age advances, the tissue of the nerve appears to become denser, less succulent, so as to occupy a smaller space than in early life. Its colour also becomes darker, and in some old persons approaches to grey, while its outline slightly deviates from that circular form which one must assume as the standard of perfect health. Indeed, it is extra-

* It is almost impossible for an artist to give a correct representation of a detached retina. A very able attempt to do so, and indeed the only one I have seen which has any resemblance to nature, is in Liebreich's *Atlas*, tab. vii. fig. 2.

† Liebreich, tab. xii. fig. 5.

ordinary to see how much variety in its size, form, and colour may co-exist with a fair amount of vision.

A very common appearance is that of a thin line of black pigment skirting the margin of the optic nerve to the extent of a sixth, a quarter, or the half of its circumference. Strictly speaking, we must regard this pigmentous deposit as morbid; but its existence cannot be of any great importance, inasmuch as we so frequently meet with it in eyes which, if judged by their power of vision, may be termed healthy.

Inflammation ('optic neuritis') attacks the nerve in various forms. Sometimes it is evidenced by extreme hyperæmia, the whole disk assuming a pink or reddish colour. After this redness has existed a considerable time, attended with great dimness of sight, it slowly passes off, but the nerve does not resume its healthy aspect. On the contrary, it either presents a dead white appearance, or a dirty-grey tint; in either case the blood-vessels remain much diminished in size, and vision is almost or altogether lost.

This form of optic neuritis is occasionally met with as a result of excessive indulgence in tobacco.

That too great use of this narcotic has, in certain constitutions, a direct tendency to induce disease in the optic nerve, can no longer, I think, be doubted. I say 'in certain constitutions,' for it is notorious that a vast proportion of those who smoke tobacco do so with impunity so far as sight is concerned.*

Another form of neuritis either co-exists with syphilitic iritis, or is liable to come on several weeks or months after all inflammatory appearances in the iris have passed away. The area of the pupil may be quite free from deposit, there may be no trace

* My limits do not permit me to enter fully upon this most important subject, but I will mention just one case, on account of its peculiar circumstances. A literary man, of large and active brain, a voluminous writer on varied topics, came under my care for gradually diminishing reading-power. He had been for years a hard worker, reading and writing many hours each day. His hobby was tobacco-smoking, which he believed to be essential to the due action of his intellectual powers, and except during the time devoted to sleep and to meals, the pipe was seldom laid aside. He wrote a history of tobacco, and held public disputations in defence of its use. He lived by his pen, and when he began to find reading and writing a little difficult, he only smoked the more. I found all the media clear, both optic nerves small and anæmic, and the retinal vessels diminished in size. He could no longer read ordinary type, and when I last saw him he was compelled to give up literary pursuits altogether.

of redness in the sclerotic, and yet the sight becomes as dim as it was during the height of the iritic inflammation. In such a case the ophthalmoscope alone can enable us to form a diagnosis. The optic nerve is either wholly hidden by a filmy cloud of lymph, or its outline can be dimly traced through the cloud, which not only involves the optic disk itself, but obscures the adjacent portion of the retina. If a case of this kind is neglected, the lymph eventually forms an opaque white patch overspreading the optic nerve, and, according to the amount of deposit, sight is either greatly obstructed or wholly destroyed. If the case be seen at an early stage, a careful mercurial treatment, either with or without iodides according to circumstances, may cause complete absorption of the lymph.

One of the most remarkable changes to which the optic nerve is liable, is that observed in cases of blindness from cerebral disease, involving that portion of the nerve which is contained within the cavity of the skull. In old-standing cases of this kind we find evidences of chronic congestion of the retina, and degeneration of the optic disk. The fundus presents a uniform red colour, sometimes so strongly marked that no trace of separate choroidal vessels can be seen, and the vessels radiating from the centre of the nerve are almost lost in the deeply-tinted surface on which they lie. Contrasting strongly with the redness surrounding it, the optic nerve at once attracts attention by its extreme whiteness, which resembles that of ivory, rather than the creamy or faintly pinkish tint which I have described as characterising the nervous tissue in a state of health. These dense-looking, homogeneous nerves have undergone *white atrophy*, and have lost the greater portion of their true nervous element, little more than the fibrous tissue remaining. (Plate III. fig. 2.) The combined appearance of a red, thickened retina, and a homogeneous, white, optic nerve, at once assures the practised observer that the case is quite beyond recovery.

In a practical point of view there is no change in the optic nerve more important than the pitting or *excavation* which is connected with glaucoma. This appearance can be well seen only in the early stage of the disease, for after a while a change in the corneal epithelium takes place which prevents any clear view of the fundus of the eye. When the concavity of the nerve is considerable, the retinal vessels are seen to bend abruptly as they are passing over the edge of the depression. (Plate I. fig. 2.)

The colour of the nerve is at first not much altered, but after a time it assumes a greyish tint, which, under certain conditions of illumination, appears darker than it really is. These changes will be again alluded to in the chapter on glaucoma.

Cases of greatly impaired sight are met with in which the optic nerves are found as deeply excavated or cupped as in the most advanced stage of glaucoma, while there is an absence of all the other signs of this disease; the corneæ being clear and smooth, the irides active, and the globes not harder than natural. Simple wasting (*grey atrophy*) of the nerve seems to be the cause of its concave appearance.

Atrophy appears sometimes to affect the whole retina and optic nerve, without any previous inflammatory process. This condition is chiefly met with in old persons; it also may befall those in the middle period of life. The power of sight gradually fades away year by year, until eventually mere perception of light remains. The ophthalmoscope reveals a perfectly clear condition of the media, and at the same time affords such a complete view of the choroidal vessels, that the observer could almost fancy the retina to be altogether absent. The optic nerve is small and shrunken, irregular in its outline, and of a dark grey or drab colour; and the vessels emerging from it form delicate, hair-like, red lines, barely traceable across the area of the illuminated choroid.

In some instances I have seen this extreme atrophy of the retina accompanied with a very remarkable change in the choroidal vessels, their colour being pale orange or buff, instead of red.* This appearance I have met with only in old people; and their failure of sight has been so slow, and unattended with marked symptoms of any kind, that they have been supposed to be the subjects of steadily advancing cataract.

Treatment.—If the reader now refers back to the sketch I have given of the morbid changes in the retina and choroid, he will at once perceive how impossible it must be to lay down any rules for treatment that will be uniformly applicable to all so-called ‘amaurotic’ cases. In a group of patients, complaining of almost the same defects of sight, one will be discovered to have a portion of the retina overspread with blood; in a second, the axis of vision will be occupied by a patch of

* See E. Jäger, *Beiträge zur Pathologie des Auges*, taf. vi.

pigment; while in a third, the retina and choroid will be partially separated by serous effusion.

Are these three patients to be treated alike? Do they, in fact, possess anything in common? And yet formerly they would all have been classed together as 'amaurotic,' and probably have undergone salivation accordingly.

If the ophthalmoscope had done nothing else than limit the wholesale administration of mercury in eye-diseases, it would have conferred an immense boon upon mankind.

Even when it has been ascertained that an extravasation of blood has taken place from the vessels of the retina or the choroid, the treatment will require great care and discrimination on the part of the surgeon. In one case the extravasation will have been accompanied, or immediately preceded, by giddiness and other symptoms of disordered circulation in the brain, and may have been induced by alcoholic or other stimulus, or by great muscular efforts in a plethoric and vigorous subject. Rest and abstinence may be indicated as the first preparatives for treatment. In another case, rupture of a retinal vessel may have occurred in a feeble and delicate patient, during a period of perfect repose, and may have resulted from a diseased and softened condition of the coats of the vessel itself. I have seen extravasations take place in such subjects in consequence of sudden exposure to cold, especially when the body or mind had been previously much exhausted. Here, moderate stimulants would be beneficial, and the absorption of the effused blood would be hastened by medicines of a tonic character—iron or quinine.

In all cases of extravasation of blood from the vessels of the retina, the surgeon should take care not to make unnecessary examinations with the ophthalmoscope, as each occasion of exposure to its strong light increases the congestion of the part, and consequently the liability to farther extravasation. I have known several instances of this kind, in which a fresh escape of blood immediately followed the use of the ophthalmoscope. Having once clearly made his diagnosis, the surgeon may be satisfied as to the progress of absorption by the steady improvement of the patient's sight, and may postpone any farther use of the ophthalmoscope until recovery has been well established.

Where serous effusion has taken place between the choroid and retina, in addition to other general treatment, iodine internally,

combined with blistering in the neighbourhood of the eye, may be tried ; although, if the effusion be of old standing, and to a large amount, little, if any, benefit can be hoped for.

It must be evident that structures, like the choroid and retina, which derive their supply of blood from such remote and deep-seated sources, cannot be treated by local depletion, even if depletion were desirable. The surgeon must seek to restore the balance of the patient's circulation by general treatment, based on a careful and comprehensive survey of constitutional peculiarities and mode of life, and especially of the habits or pursuits which may be supposed to have given rise to the local changes. Inquiries must be instituted as to the existence of any of those causes which impair the sight by exhausting the patient's general nervous power. The abuse of alcohol, tobacco, or opium ; venereal excesses ; protracted suckling, and many other depressing agencies, will suggest themselves to the mind of the acute practitioner. He will take care not to trust too implicitly to this or that article of the pharmacopœia, and will especially be on his guard against the depressing agency of mercury—the drug which he will find lauded almost as a panacea for ‘amaurosis’ in some of the medical works of the last generation.

Galvanism and strychnine he will frequently hear spoken of as possessing wonderful efficacy in arousing the dormant powers of the optic nerve. The action of strychnine appears so entirely limited to the motory fibres of the nervous system, that to expect it to influence a nerve of special sense is to confuse all our notions of physiology. Galvanism has been at various times a favourite remedy with the public, and its administration admits of a parade of scientific apparatus which specially imposes on the popular mind.

Those who believe—or make their patients believe—that they can render cataractous lenses transparent by means of galvanism, will doubtless long continue to vaunt its efficacy also in cases of the most complete disorganisation of the retina.

An anatomical classification of eye-diseases—the arranging of them, that is to say, according to the changes of structure which cause the impairment of sight—has such obvious advantages that it has become almost universal among ophthalmic writers ; but it has the inconvenience of offering no heading under which to place certain defects which cannot be precisely

demonstrated as originating in any one part of the optic apparatus.

Of this kind are the various luminous appearances depending upon some temporary disturbance of circulation—occasional obscuration of half the field of vision (*Hemiopia*)—the condition termed *Hemeralopia*—congenital inability to distinguish certain colours—spectral illusions, &c.

Faulty perception of colours.—The following list comprises only a portion of the many terms invented to designate this affection: *achromatopsia*, *chromatopseudopsia*, *chromatometablepsia*, *chromatodysopsia*, *chromatopseudoblepsia*, *dyschromatopsia*. These words, it will be observed, all imply difficulty or inability to see colours; but in fact the subjects of this affection are not insensible to all, but only to some colours, while others are seen perfectly. The term *colour-blindness*, employed by Wilson,* is on this account objectionable. *Daltonism* † commemorates the faulty perception of an individual, without conveying any notion of the nature of the defect. I have suggested the word *acritochromacy*, ‡ as implying ‘inability to discriminate between colours,’ which pretty nearly defines the true nature of the affection.

On investigating the reported cases of ‘acritochromacy,’ the defect appears in most instances to resolve itself into inability to perceive red; and the compound tints suggesting doubtful impressions are those into which red enters to a greater or less extent. Yellow seems to be always appreciated, and blue almost always.

The cause of the defect probably resides not in the eye itself, but in that portion of the brain to which the impressions of light are ultimately conveyed. Hitherto very few dissections have been made of the eyes of ‘acritochromatic’ persons. Dalton had supposed a blue tint of the vitreous humour to be the cause of his own peculiarity, and, in accordance with his express wish, his eyes were examined after death, but nothing unusual was discovered.

Acritochromacy may take place as a temporary morbid symptom.

* See *Monthly Journal of Medical Science*, Edinburgh, July 1854, p. 1.

† From Dalton the chemist, who published his own case in the *Memoirs of the Literary and Philosophical Society of Manchester*, 1798, vol. v. p. 28.

‡ 'Ακριτοχρωμαρία.

Some years ago a very intelligent and sensitive little girl, ten years old, was brought to me in consequence of almost total blindness, which had come on within the preceding four days. She was unable to guide herself, and, if left alone, could not avoid the articles of furniture in the room. She with difficulty perceived a sheet of paper lying on the floor, and, of course, was wholly unable to distinguish the largest type. She had been much excited by the emulation of a school-competition, and had taxed her memory considerably in learning by heart. Slight dilatation and sluggishness of the pupils were the only ocular symptoms; but she dreamed vividly, occasionally felt faint during the day, and had numbness and formication in the left leg and foot. I enjoined complete rest, and prescribed iron in small doses. Within a week she could trace lines of type as streaks, but was quite unable correctly to appreciate colours. She had no difficulty with yellow and blue, but mistook all tints containing red. Ten days later her general health was restored, and with a little pains she could read the type of a leading article in the *Times*; but her appreciation of colours was still imperfect. At the end of a few weeks all defect of sight was gone; she read the smallest type, and her power of discriminating colours was quite restored.

Wilson has insisted upon a very important practical point connected with 'colour-blindness,' as he terms the defect, namely, that persons employed on railways and elsewhere, where coloured lights are used as signals, should be previously tested as to their power of perceiving colours with perfect accuracy. On many occasions our lives depend on the ability of some solitary signal-man to distinguish between green, the sign of safety, and red, that of danger. Now that an universal railway system has forced upon us a mode of travelling fraught with incessant peril to life and limb, we cannot afford to neglect a single chance of safety.

There seems to be no cure, or even palliation, of a defect which appears to depend upon a congenital want of appreciative power in the brain itself.

Hemeralopia—literally 'day-sight'—is a term used to designate a peculiar form of intermittent blindness, the subjects of which see perfectly in broad daylight, but lose all power of perceiving objects as soon as the sun has set, and twilight commences. The persons in whom the affection is most frequently met with in this country are those just returned from sea-voyages, especially from the East or West Indies. It is also frequent, I am told, among the natives of the inland parts of India, who attribute it, as our own sailors do, to sleeping exposed to the moonbeams.

The real cause of *hemeralopia* appears to be exhaustion of the nervous power of the retina from over-excitation by the sun's rays, so that the part is rendered incapable of appreciating the

weaker stimulus of twilight or moonlight. Exposure to tropical light, however, is not the sole cause of the affection ; for I have met with it in persons who had never quitted the temperate regions of the globe ; but in most of these latter cases the complaint had shown itself after long voyages, which had subjected the patients to exhausting toil and exposure to severe weather, while deprived of a proper supply of fresh provisions and vegetables.

In these latter cases I have commonly found that a few weeks' residence on shore, with a mixed vegetable and animal diet, and the use of quinine, has restored vision to a healthy state.

Nyctalopia—‘night-sight’—would imply inability to see by daylight, the exact converse of *hemeralopia*. In a certain sense, patients affected with that irritable form of corneal inflammation commonly called ‘strumous ophthalmia,’ might be termed *nyctalopic*, so unable are they to bear strong light, and so willing to open the eyes and look about them in the dimness of twilight ; but, apart from inflammation, I have never met with *nyctalopia* to the extent described by authors ; and I am inclined to consider the affection an imaginary one, invented, as it were, to form a companion disease to the *hemeralopia* just described.

CHAPTER VIII.

DISEASES OF THE VITREOUS BODY.

BEFORE the invention of the ophthalmoscope, little was known about the morbid conditions of the vitreous humour. It was frequently found to become diffuent (*synchysis*) after injuries to the eyeball, and during the progress of certain chronic inflammations ; and it was assumed to play an important part in glaucoma. The ophthalmoscope presents to our view a great variety of morbid products in the humour, which it is difficult to observe with accuracy, on account of the rapidity with which many of the flakes, filaments, and corpuscles, float about with every movement of the eye.

When *hæmorrhage* occurs from the ciliary processes, or from the superficial vessels of the retina, a portion of the clot not unfrequently becomes entangled in the vitreous humour, and

forms an irregular, filamentous, black-looking* body, floating to and fro across the illuminated field of the ophthalmoscope.

In *syphilitic inflammation* of the deep tissues, the vitreous humour loses its perfect transparency, and becomes turbid; and in severe cases, flakes of lymph are seen freely moving about in it, like tangled blackish threads.

A very singular phenomenon connected with the vitreous humour is that termed *sparkling synchysis* ('synchysis étincelant'), produced by the disintegration of an altered crystalline lens. This body, after becoming opaque from ordinary cataractous change, sometimes undergoes extensive fatty degeneration, crystals of cholesterine being abundantly formed within its substance. If a lens in this condition is broken up with the needle, or becomes ruptured and thrown down to the bottom of the vitreous chamber by a blow, the crystals of cholesterine are set free, and at each movement of the eye appear as innumerable brilliant points, like the finest gold-dust, sparkling in the dark area of the pupil. When the eye is kept at rest these crystals gravitate to the bottom of the mingled aqueous and vitreous humours, some sinking down behind, and some in front of the iris.

Sparkling synchysis is very rare, and I have not had an opportunity of examining any cases with the ophthalmoscope.

Cysticerci.—Perhaps the most striking phenomenon connected with the vitreous humour is the presence of entozoa, either freely floating within it, or protruding into it from the surface of the retina, to which they are attached. By far the greater number of cases of this kind which have been recorded are to be found in foreign journals, for hitherto only a very few have been observed in this country. I have myself never met with a case.†

Of twenty cases reported in various numbers of the *Archiv für Ophthalmologie*, the majority appear to have been under the

* I may here notice that floating bodies in the vitreous humour are not necessarily black because they look so under the ophthalmoscope. Any body sufficiently opaque to intercept the rays of light passing from the illuminated retina to the eye of the observer will appear black, although if examined out of the eye, it might be found light-coloured or even white.

† Teale gives the history of a case occurring in his own practice in 1864 (*Ophth. Hosp. Reports*, vol. v. p. 318). Bowman reports another (op. cit. vol. iii. p. 324). Hulke, in dissecting a disorganised and irritable eye, found a cysticercus between the choroid and retina.

care of Graefe. In *eight* cases the cysticercus was either embedded in the very tissue of the retina, or firmly adherent to its surface; in *six* cases, the creature appeared to be behind the retina; while in *six* others it was quite detached, and floated freely in the vitreous humour. This latter circumstance induced Graefe, in two instances, to attempt its removal; in the first case, making an incision in the sclerotic and passing in a forceps through the wound; in the second, adopting a slower and more complicated proceeding. First, a portion of the iris was excised, so as to make a large artificial pupil; then, when all irritation had subsided, the lens was extracted through a flap-section of the cornea; and lastly, after a considerable interval of time had been allowed to elapse, a forceps was introduced through a fresh opening made in the cornea, and the cysticercus grasped and drawn out.*

From a review of all these cases, it appears almost certain that the cysticerci found loose in the vitreous humour had attained that position by perforating the retina, having been originally formed between that tissue and the choroid, in which situation it seems that all the cysticerci above described were originally developed.

In a more recent volume of the *Archiv*, Graefe gives the total result of his experience as to the occurrence of cysticercus (xii. 2, 174; 1866). During thirteen years 80,000 patients had attended his clinique, and among them rather more than 80 cases of cysticercus in the deep tissues of the eye had been observed: 3 had been seen in the anterior chamber; 5 under the conjunctiva; 1 in the substance of the lens; 1 in the orbit. The ages of the patients varied from eight years to seventy.

The very curious researches recently made into the natural history of intestinal parasites have proved that the *cysticercus telæ cellulossæ* and the *tænia* are really the same creature in different stages of development.†

I believe it has been well ascertained that the inhabitants of Northern Germany are more liable to tape-worm than those of the British Islands, and this circumstance would account for

* A case of cysticercus in the vitreous humour is related by Desmarres, *Traité théorique et pratique des Maladies des Yeux*, 2nd edit. 1858, vol. iii. p. 756. Another by Williams in the *Cincinnati Lancet and Observer*, May 1858. See Liebreich's *Atlas*, tab. vii. figs. 5 and 6.

† See Küchenmeister and Von Siebold, *On Animal and Vegetable Parasites* (Sydenham Society, 1857).

the fact of the cysticercus having been so much more frequently met with in the former country.

Muscæ volitantes.—The little threads and spots which, by some persons, are seen to float and glide over their field of vision, were formerly attributed very commonly to congestion of the choroid. Tyrrell, for instance, assigned as their cause 'a preternatural dilatation of some of the delicate vessels' of the part. It seems strange that any one could overlook the fact that *fixed* bodies—which dilated vessels of the choroid must be—if they pressed upon the retina so as to impair its function, would suggest to the patient the idea of *fixed* spots in the field of vision, which could only appear to move when the eyeball itself was set in motion. The spots known as *muscæ volitantes*, on the contrary, change their position whenever the eye is suddenly moved; and when the eye is again fixed, the spots still continue for a time to float about in various directions, eventually appearing to descend, as if sinking in a fluid.

They are most commonly met with in short-sighted subjects, and are quite compatible with life-long continuance of the acute powers of vision which such persons frequently enjoy. They are usually first noticed between the ages of twenty and thirty; and when they have begun to attract the patient's attention, they appear rapidly to increase in number. This apparent increase is partly due to the fact that, by anxiously watching them, the patient soon acquires a habit of bringing fresh bodies into view.

If the eye be turned towards a clear sky or a bright cloud, and then kept steadily fixed, the spots appear to sink slowly downwards, just as filmy particles would sink in a liquid, which had been shaken and then allowed to rest. A sudden turn of the eye will again cause the little bodies to disperse for a moment, and when the eye is once more fixed, they slowly descend as before.

So long as the patient steadily concentrates his attention on any external object, the *muscæ* are not seen; but if he accidentally catches sight of one of them the whole field of vision at once becomes crowded with them.

The best way of examining the floating bodies is for the patient to look directly downwards upon the illuminated field of a microscope. They will then be recognised as beaded filaments, variously twisted and bent; sometimes appearing as loose knots of coiled-up fibres entangled together. When thus

grouped they have a greyish colour, but when a single filament is examined, it is seen to be made up of highly-refractive globules, varying in form and size. Sometimes a filament may be seen to bend, and again become nearly straight, or to turn in such a manner as to present itself in a foreshortened position. This latter circumstance proves that the bodies float freely in a fluid, and are not situated, as some have supposed, upon the surface of the cornea. This is still further proved by the fact that the blinking of the lids has no effect whatever upon the position of the *muscæ* in the field of vision. If, when the lids are closed, the eyes are turned towards a strong light—exposed to sunlight, for instance—the *muscæ* can still be seen, and their movements will be just as free as when they were observed with the eyes open.

Some interesting experiments were made on himself by Mackenzie,* to determine the seat of *muscæ volitantes*; but the most conclusive researches as to their nature are those by Jago,† who has satisfied himself that these disquieting spectres are, in fact, nothing more than the beaded filaments of the vitreous body itself. The normal network of these filaments, he says, can be seen by any one who knows how to look for them—under certain conditions, I presume, of impressibility of retina. Those filaments which, from being tangled together in irregular masses, form such annoyances to the patient, would appear to be the filamentous network in a disintegrated state.

There are few phenomena which give rise to more alarm in patients' minds than *muscæ volitantes*. A vague notion that they are the forerunners of amaurosis or cataract is almost universal; and even medical men are apt to confound these *floating muscæ* with the moving cloudy shadows resulting from effusions of blood or lymph within the vitreous humour, or with the fixed spots betokening that some limited portion of the retina has become insensible to light. A careful attention to the appearances of the *muscæ volitantes*, as I have described them, will enable the patient to convince himself of their real nature; and the surgeon may console him with the assurance that, although incurable, they are perfectly compatible with excellent and enduring sight.

* First in the *Edinburgh Med. and Surg. Journal*, for 1865; and again in his *Practical Treatise*, &c. 1854, p. 951.

† *Entoptics, with its uses in Physiology and Medicine*, 1864, p. 93.

It is to be hoped that medical men in general will speedily arrive at this conviction; for it is lamentable to meet with patients who have gone through years of treatment, often of the severest kind—even to bleeding and salivation—or at best through an equally ineffectual course of tonics and local applications, and after all have remained with their *muscæ* undiminished, and their minds still burdened with anxiety and fears of approaching blindness.

Appearances so common as floating *muscæ* will of course be observed by multitudes of persons who subsequently may become the subjects of either retinal disease or cataract. All I mean to insist upon is, that the *muscæ* and the diseases of retina or lens have no causal relation to each other.

CHAPTER IX.

DISEASES OF THE LENS AND CAPSULE.

IN a state of health the lens and the membranous capsule enclosing it are perfectly transparent. In early life they are also quite colourless; but after the age of thirty the lens in most persons begins to assume a pale-yellow tinge; and this gradually becomes more marked as age advances, until in old subjects it frequently acquires the colour of amber.

Any loss of transparency in the lens, whether affecting the whole or only a portion of it, constitutes *cataract*; and in strictness this term should be limited to changes in the lens and its capsule. To call an opaque inflammatory effusion in the area of the pupil a ‘spurious cataract,’ is to introduce a loose and uncertain terminology, which can only give rise to confusion in our descriptions of disease.

Abnormal position of the lens.—The ‘suspensory ligament,’ which is attached to the capsule all round the margin of the lens, maintains it in a fixed position. A blow on the eye sometimes ruptures a portion of this ligament, and allows the lens to become tilted backwards. If the ligament is detached to a considerable extent, the lens sways to and fro with every movement of the globe, and vision is much confused. Eventually, under such conditions, the lens becomes opaque; but I have seen cases in which it remained transparent for a very considerable time.

It appears that the suspensory ligament is liable to a congenital defect, whereby the lens, instead of maintaining its normal position, undergoes displacement in a lateral direction, so that its centre no longer coincides with the centre of the pupil. A curious instance of this malposition of the lens occurred in a mother and three children who came under my care. In the mother, and in one of the sons, both lenses were displaced upwards and inwards; in another son, directly inwards; and in the third, directly upwards. In none of these cases did the lenses deviate, or only in the slightest possible degree, from their normal transparency.*

CATARACT.

This term, as I have already observed, should be strictly limited to denote partial or complete opacity of the lens.

The existence of capsular cataract has of late years been called in question, and I shall presently notice the grounds of this new opinion.

Opacities of the lens do not appear to be all of precisely the same nature. Some depend upon a shrinking and wasting of the fibres themselves, without any appreciable change in their chemical composition, while the more strongly-marked and chalky-looking streaks and spots are formed by new deposits of earthy and fatty material.

We shall best appreciate the changes which take place in cataract by glancing at the anatomy of the lens. It is completely enclosed within the very thin, but strong, capsule, which is throughout perfectly transparent and homogeneous. To this capsule is attached the 'suspensory ligament of the lens,' which passes off from the back of the ciliary processes to be implanted into the capsule of the lens, with which it becomes identified. Immediately within the capsule is a layer of cells; internally to this layer are arranged the superficial fibres of the lens, softer and of a more fragile consistence than those forming the centre or *nucleus*. The fibres of the lens are disposed in planes, the exact arrangement of which cannot easily be understood without the aid of diagrams; it may suffice for our purpose, however, to state, in general terms, that the fibres form radii

* See a description of these cases in *Ophthalmic Hospital Reports*, vol. i. p. 54, 1858: also in my *Guide to the Practical Study of Diseases of the Eye*, 2nd edit. p. 401.

converging from the circumference to the centre, and are more curved as they are nearer to the anterior and posterior surfaces of the lens, and less curved as they approach its vertical plane.

Such being the manner in which the elements of the lens are arranged, we shall at once perceive the reason why the opacities of cataract present such different appearances, accordingly as they are in the superficial cellular, or the deeper fibrous layers.

When the superficial cells and adjacent soft fibres of the lens become disintegrated and broken up, and intermixed with generally diffused earthy deposits, the whole area of the pupil presents a milky appearance, without any regular striæ being visible. If the softening process has been going on for a long time, there is usually an abundant formation of fatty matter, and the faintly-bluish skim-milk colour gives place to a slightly yellow tint, like that of cream.

If, however, the cataractous opacity commences in the unbroken fibres of the lens forming its cortical portion, whitish streaks are seen converging from the circumference towards the centre. In persons past middle life some of these streaks have a slightly-yellow cast, while others are perfectly white. This difference of tint depends upon the fact I have already noticed, namely, that the body of the lens, after the age of thirty or forty, acquires a yellow tinge; and consequently, although the opaque streaks are in themselves white, only those appear so which are on the anterior face of the lens, and are viewed through the colourless media of the cornea and aqueous humour; while, on the contrary, the streaks on the posterior face of the lens, being seen through its still transparent, although yellowish, body, acquire a corresponding change of colour. A practised eye will also recognise a difference of form between these two sets of striæ; those on the front of the lens presenting a convexity, and those on the hinder face a concavity, towards the plane of the iris.

These striæ can be clearly seen only in the earlier stages of cataract, for eventually the superficial fibres and cells become broken up and disintegrated, and then the lens presents one uniform whitish or greyish surface.

The fibres of which the *nucleus* consists are denser and firmer than those constituting the cortical portion; but they are disposed in the same radiating form. When this nucleus becomes opaque in old age, it does not present the marked striæ so

characteristic of *cortical* cataract, but assumes a more uniformly cloudy appearance. The distinction between the *cortical* and the *nuclear* portions of the lens are best seen in the common form of congenital cataract, in which the whole nucleus is opaque, while the periphery remains almost or quite transparent.

I have briefly alluded to the doubts which some histologists have thrown upon the existence of 'capsular cataract'—a term employed even quite recently as designating one of the two grand divisions of cataractous opacities. These doubts chiefly originated with Stellwag,* who, after carefully examining with the microscope about fifty cataracts with apparently opaque capsules, asserted that in every instance the opacity was caused by substances *attached* to the lenticular surface of the capsules, but not *deposited* in the very tissue of the capsules themselves. The opaque material which, to the naked eye, seemed identified with their tissue, chiefly consisted of earthy and fatty deposits, firmly adherent to it, but yet separable by mechanical or chemical means.

The marbled and mottled appearance commonly described as characterising 'capsulo-lenticular cataract' is said by Stellwag to depend upon the irregular manner in which the earthy and fatty material is deposited on the inner surface of the capsule.

Although the facts pointed out by Stellwag and others may justify us in discarding the term 'capsular' as designating a species of cataract, it would be affectedly precise to abandon the term *opaque* as applied to a portion of capsule impeding vision, merely because the opacity may be due to earthy or fatty matter adhering to the membrane. And, indeed, a portion of capsule which is transparent and invisible when perfectly tense, will become opaque when relaxed and thrown into folds.

Reverting to the changes in the lens itself, I would observe that a very common error exists with regard to the use of the terms *hard* and *soft* as applied to cataract. These terms are employed as if, in certain cases a softening process set in from the very first, whilst in other cases the reverse took place, and the whole lens underwent a steady process of hardening. But if we examine a healthy lens at the infant period of life, and compare it with one which is congenitally opaque, we shall find but little difference in the consistency of the two structures.

* *Die Ophthalmologie*, 1853-58.

In the adult, the lens retains nearly its normal consistency so long as the opacity remains at the striated stage, and it is not until after a considerable period that the superficial portion of the lens undergoes that process of disintegration which imparts to it the uniformly whitish and milky appearance.

Again, in old subjects the commencement of cataract is not attended with any marked hardening of the lens, although, as the nucleus becomes opaque, its fibres appear to undergo a certain process of drying and atrophy. But even in the oldest persons superficial softening eventually sets in, usually many years after the first commencement of opaque striæ.

Hence it will appear that the terms *hard* and *soft* express only a certain stage in the progress of a cataract; that in no form of the disease does the lens from the very beginning undergo progressive hardening; but those lenses which for a long time retain their normal firmness while opacity is advancing, eventually become softened, and may even, in the lapse of many years, undergo a complete transformation into a fluid condition.

Under the two heads, *Nuclear* and *Cortical*, we may arrange all the various forms of cataract; abolishing the old term 'capsular cataract,' and assigning those opacities which were formerly known by that name to the *cortical* division.

Nuclear cataract would comprise, first, the congenital form of the disease; and, secondly, that which is met with in old age, either alone, or, more frequently, associated with marginal striæ.

Cortical cataract is by far the more usual form; for the opacity which occurs in middle life almost invariably commences in the cortical portion of the lens; and even in old age this is the rule, the rare exception being that the nucleus becomes cloudy before marginal striæ are developed.

It was owing to insufficient exploration of the eye that the reverse of this was formerly believed to be the case; but no one can have had extensive opportunities of examining the eyes of old persons under the influence of atropine, without convincing himself that, even in extreme old age, it is much more common to find marginal opacity beginning whilst the nucleus is still clear, than to find nuclear opacity beginning while the margin of the lens is transparent.

Diagnosis of cataract.—There is no better test of an ophthalmic surgeon's skill than his ability to determine the presence or absence of opacity in the lens. And nothing is more impor-

tant to be precisely ascertained; for the want of skill to detect cataract in an early stage may lead the surgeon to regard the case as one of retinal defect; or, on the other hand, he may mistake the reflex of light from the retina for the opacity of cataract.

I will not detain the reader with a long account of the *subjective* symptoms which attend cataract; for the detection of the disease depends wholly upon a careful examination of parts lying open to our observation. A full detail of subjective symptoms is, no doubt, very useful in ascertaining the morbid condition of a structure wholly concealed from our view; but this is not the case with the lens, and if we suspect opacity to exist, we have simply to look for it.

A more or less marked dimness of sight, uniformly involving the field of vision—coming on gradually, and without inflammation, unattended with any impairment of motory power in the iris—such would be the symptoms which would make us suspect the existence of cataract. Our examination should be conducted in the following way:

The patient should be placed close to a window admitting bright daylight—not direct sunlight—and care should be taken that the light does not fall upon the cornea from more than one window, and that reflections from mirrors and other polished surfaces do not interfere with the single ray which should pass into the pupil. A convex glass of an inch focus should be used as a condenser, to concentrate light upon the surface of the patient's lens, while we explore it with the naked eye. In this manner faint streaks of opacity may be detected, which would otherwise escape us. Each eye must be separately examined.

We must never rest satisfied with a patient's assurance that he can or cannot read, but must obtain a precise standard of his sight by making him read aloud from type of different sizes.

In hospital practice, those who have not learnt their letters may be told to count dots, point out a single and a double line, an asterisk, and other typographical marks.

All these experiments must be made while the eye is in its natural state. We next proceed to dilate the pupil with atropine. A solution of two grains to the ounce of distilled water is usually strong enough for this purpose, and care should be taken to obtain the sulphate perfectly neutral. Any excess of acid makes the application painful, and so of course does

the addition of alcohol, which I have sometimes seen prescribed. The lower lid should be slightly drawn away from the globe, and a few drops of the solution let fall between them ; and then the lids should be kept closed for a quarter of an hour or half an hour. Children, and even timid adults, are often alarmed at the sight of any bottle of drops, so instinctively do they suspect that all drops necessarily cause pain. A disk of atropised gelatine may be quietly slipped on to the conjunctival surface of the lower lid, without the patient being aware that any such application has been made.

When the pupil is fully dilated, we repeat our examination as before, with the aid of concentrated daylight, carefully illuminating and exploring the extreme margin of the lens, and, if its body be sufficiently transparent, lighting up and examining its posterior surface. In this manner the faintest streaks of commencing cataract may usually be detected ; while dense patches along the margin of the lens, opaque striæ converging along its anterior or posterior surface, delicate lines radiating from the centre, or the uniform haze of a cloudy nucleus, can hardly escape detection.

While cataract is still in a very early stage of development, it is so important to ascertain the condition of the retina and choroid, that in every case the ophthalmoscope should be used to complete our diagnosis.

By examining the deep tissues we sometimes detect in them morbid conditions, which would induce us eventually, when cataract had become complete, to abstain from operating ; or, if an operation were deemed desirable, it would be undertaken on the full understanding that only partial success would be attainable.

Reasoning *à priori*, we should imagine that the ophthalmoscope would be an infallible means of detecting those faint traces of cataractous opacity which elude the ordinary modes of observation ; but experience shows us that, under the strong glare of the ophthalmoscope, these faint opacities frequently disappear, just as a slight flaw in a piece of glass might become visible when laid upon a black surface, although it would not be seen when the glass was held in front of a brilliant light.

In most cases, however, the opaque striæ of a commencing cataract are seen under the ophthalmoscope as radiating black lines, while a hazy nucleus assumes the appearance of a dark cloud in the centre of the pupil.

Sometimes the very earliest commencement of cataract may be detected by examining the lens with the naked eye in a darkened room, while a strong light is thrown upon the part either from the ophthalmoscopic mirror, or by means of a convex glass of a short focus. This oblique illumination will often reveal highly-refractive globules and radiating lines throughout the whole extent of a lens, which to ordinary ophthalmoscopic examination seemed transparent.

I have already spoken of the twofold division of cataractous opacities into cortical and nuclear, accordingly as they are situated in the periphery or the centre of the lens. To give any special names to cataracts, in consequence of the various shapes which the opaque deposits assume, appears to be altogether trifling and useless. It is evident that the transparent and opaque elements of a diseased lens may arrange themselves in such a manner as to produce infinite variations of shades and figures, without offering any real variety in their composition. There are, however, a few leading peculiarities connected with age and mode of development, which demand a separate notice.

CONGENITAL CATARACT.

This opacity may exist in very different degrees.

1. The slightest form is that of a small white central dot on the anterior face of the lens (*Cataracta centralis*). This dot consists of a minute portion of earthy matter deposited in the most superficial portion of the lens, just within the capsule. In cases of this kind the rest of the lens commonly remains throughout life transparent, and the patient is often unconscious of any defect of vision. Occasionally, however, a few faint white lines are seen radiating from the central dot. If the rest of the lens remains transparent, this slight form of cataract should by no means be treated by operation.

2. Sometimes, instead of forming a minute central dot, the earthy deposit is so large as to occupy nearly the whole area of the pupil, when in its contracted state. The deposit projects forwards in the shape of an obtuse white cone, and appears to adhere by its base to the anterior surface of the capsule. This, however, is not really the case, the cretaceous mass being embedded in the superficial portion of the lens, and covered by the transparent capsule. The term *Cataracta pyramidata* has been given to this congenital form.

3. The most common kind of congenital cataract is that in which the nucleus is opaque, while the peripheral portion remains transparent. In the contracted condition of the pupil this transparent portion is hidden by the iris, but it comes into view when the pupil is widely dilated. In the contracted, or but slightly dilated, state of the pupil, its entire area is occupied by a greyish-white opacity, made up of fine radiating lines, which converge to an opaque white patch at the centre of the lens. When the pupil is widely dilated with atropine, this opacity is seen to be surrounded by a perfectly black area, and through this clear ring-shaped space the patient has tolerably clear vision. Those who examine such cases for the first time are apt to imagine that the opaque nucleus which they see really constitutes the whole lens, shrunken and contracted to an unnaturally small size, and that the dark ring-shaped space is altogether unoccupied by lens-tissue. Occasionally a few white lines are seen to traverse this space, passing from the opaque nucleus to the outer margin of the lens. When such a nuclear cataract is broken up with the needle, in the operation for solution, the real nature of the case is made manifest, and the peripheral portion of the lens soon becomes as opaque as the nucleus itself.

If cases of this kind are not operated upon in early life, the patients, although very short-sighted, continue for many years to enjoy considerable powers of vision; but usually, towards the age of forty, if not sooner, the peripheral portion of the lens undergoes a change, and gradually becomes opaque.

4. A form of congenital cataract, much more rare than that just described, consists of a very faintly-striated opacity of the nucleus, unaccompanied by that chalky-white central patch which renders the ordinary congenital cataract so conspicuous and so easy of diagnosis. Several instances have come under my notice, in which this rarer kind of cataract has remained undiscovered until the patients were of an age to be sent to school, when their inability to read ordinary type has caused their friends to seek advice.

5. It is very unusual to find cataract first commencing between infancy and puberty; but I have met with a few cases in which the opacity seemed to have begun when the patients were about nine or ten years old. They had been sent to school at the age of seven or eight, and had readily learned to read; but at the end of a year or two their sight began to fail, they

became at first short-sighted, and then gradually lost the power of reading any but large type, or of recognising faces across a room.

I have observed two distinct forms of opacity in these cases.

In one form the lens was dotted throughout with minute white points, arranged in the course of its fibres. These dots were as small as if pricked-in with the finest needle, and the general effect they produced was that of a very faint haziness in the pupil, only recognisable under concentrated light.

In a second set of cases the opacity was wholly confined to the posterior surface of the lens. In some instances there was one isolated patch in that situation, not exactly in the axis of the lens, but reaching from near that point to its extreme edge. In other cases the whole posterior face was covered with very fine opaque lines, closely set together, and converging from the circumference to the centre, so as to produce the effect of a delicate fibrous membrane of concave form. Encircling the exact centre of this opaque surface was a whitish ring, more dense and earthy in appearance than the rest of the striated surface of which it formed a part.

These opacities, limited to the posterior face of the lens, of course require for their detection far more careful observation than congenital cataract of the ordinary kind, in which the whole nucleus is opaque, and the centre probably marked with a chalky-white patch in the very centre of the pupil.

Congenital cataract, whatever form it may assume, is frequently accompanied by a rhythmical twitching movement of the eyeballs, the effect of irregular action either of the recti or the oblique muscles. This twitching is known by the name of *nystagmus*. It does not, however, invariably accompany congenital cataract, some patients suffering from this affection being entirely free from any irregular muscular action: while, on the other hand, *nystagmus* is met with in many cases of defective sight wholly unattended by any opacity of the lens.

There are certain morbid deposits in the deep tissues of the eyeball which in infants and children may be mistaken for the opacity of cataract. Scrofulous and encephaloid deposit, for instance, in their early stage, are not unfrequently mistaken in this manner; but a careful examination through a well-dilated pupil, cannot fail to detect the real nature of the disease. Both scrofulous and encephaloid deposits have a more or less yellow

colour, and by a practised observer will be recognised as lying much farther back than the hinder surface of the lens. At a certain stage, however, of scrofulous and encephaloid deposit the lens becomes cloudy ; and how, it may be asked, is a secondary cataract of this kind to be distinguished from one which is primary, and unconnected with any other affection of the globe ? In an eye affected with simple cataract the position of the iris is usually vertical, or nearly so ; the pupil is active ; the lenticular opacity is regularly striated, and perhaps exhibits also at its centre a white dot. In advanced scrofulous and encephaloid disease, on the contrary, the anterior chamber is obliterated, the pupil is irregular, dilated, and fixed ; the lens has an uniformly cloudy appearance, and sometimes receives from the mass behind it a somewhat yellowish tint. Congenital cataract, too, almost invariably affects both eyes ; while encephaloid deposit almost as invariably occurs in one eye only. Scrofulous deposit does, indeed, occasionally affect both, but rarely to the same extent, or at the same time.

In children and also in older persons who have been brought under my notice for congenital cataract, I have been struck with the frequent occurrence of diseased teeth ; the incisors and canines being dwarfed, deficient in enamel, discoloured and honey-combed on their anterior surface, and their cutting edge worn away and blunt. I am unable to offer any explanation of this condition of the teeth, which I do not find mentioned by any ophthalmic observer.

CATARACT IN ADULTS.

Except as a result of injury, cataract is rarely seen to commence between puberty and the middle period of life. Up to the age of forty it is a rare disease, it becomes more common in patients who have passed their fortieth year, but it is after the age of fifty or sixty that we are more especially on the watch for it in patients complaining of failing sight.

Even up to extreme old age cataract usually commences at the circumference of the lens, in the form of opaque striæ, which gradually advance along the anterior and posterior faces of the lens towards its axis.

About the same time very fine whitish lines may be observed to radiate from the anterior pole of the lens, marking the divisions which exist between the planes in which its fibres are

arranged. After the age of sixty a hazy condition of the nucleus is commonly found co-existing with advanced marginal opacity; but even in extreme old age it is far more common, as I have already observed, for cataract to commence at the margin than at the nucleus.

If we trace the rise and progress of cataract in an elderly person, the changes will usually be found to occur in the following order. First, opaque striæ are formed at the extreme edge of the lens, and commonly it is the lower edge which is thus affected. These striæ gradually coalesce into patches, and then spread themselves over the posterior face of the lens, only a few extending a short distance over the anterior face. At this point of development the cataract may remain stationary for a year, or even for several years. Then a farther change takes place, and the whole body of the lens, but especially the nucleus, becomes slightly hazy, but not so as to prevent the posterior radiated opacity from being recognised when properly illuminated. The opaque striæ on the anterior face of the lens gradually advance until their tips appear within the area of the pupil. The haziness of the body of the lens increases until even concentrated light fails to reveal the posterior striæ, and at last only the anterior surface of the lens can be seen. At this stage of cataract, vision is restricted to mere perception of direct light, or of that reflected from white or polished surfaces. Perhaps bright colours may still be recognised.

Up to this point the fibrous structure of the lens can still be traced; but as years go on, its surface becomes more opaque and whiter, in consequence of disintegration of the superficial fibres, and the deposit among them of earthy and fatty material. Occasionally crystals of cholesterine, just within the capsule, may be recognised by their peculiar sparkling appearance.

It sometimes happens that this final stage of superficial softening does not occur, and the cataract is then very difficult of detection, having a dull brownish appearance like horn.

A very rare form of lenticular opacity is that termed 'black cataract.' The name is frequently given to lenses which are only of a dark-brown colour, but absolute blackness is sometimes met with. It must not, however, be supposed that in these cases the blackness of the pupil is like that presented by a healthy eye, in which all the humours are perfectly clear. In the two or three cases of black cataract which I have seen, there was not the slightest doubt as to the existence of a cataract,

although the blackness, so remarkable after extraction, was not suspected; for, in each instance, several fine whitish lines could be seen radiating on the anterior surface of the lens, formed, no doubt, by slight earthy deposits just within the capsule.

Fluid cataract; Morgagnian cataract.—The softening process, which begins in the superficial portion of an opaque lens, may go on until, in the course of years, the whole mass becomes converted into a thin pulp. The nucleus, for a long time, resists this softening change, and a lens consisting of a firm nucleus, surrounded by a turbid pulp of disintegrated tissue, has received the name of ‘Morgagnian cataract.’*

As in fluid cataract all the superficial portion of the lens is disintegrated, there is of course no trace of those radiating striæ so characteristic of ordinary opacity. Sometimes a fluid cataract is bluish-white, like milk-and-water; in other cases it assumes a dirty-grey colour, or a pale-yellow tint, like that of cream. Its consistence appears unequal, as if some portions were coagulated, and others perfectly fluid.

The creamy colour is usually found in cataracts that have existed in the fluid state for a considerable time, and it seems rather paradoxical to assert that it is very difficult, even for a practised observer, to distinguish between a fluid lens of this kind and one which has undergone a change of a directly opposite character, and become solidified by earthy deposit. The perfectly fluid and the perfectly solid lens are equally devoid of fibrous markings, and the inequality of consistence in the former presents an appearance very similar to that resulting in the latter from the variety in tint, caused by the manner in

* This form of cataract was not described by the Italian anatomist from whose name the term is derived. In dissecting the eyes of animals he had observed a fluid to exude from between the capsule and the lens, and concluded that this fluid always existed during life. In compliment to the discoverer it was termed by anatomists *liquor Morgagni*, and its existence in the living eye was for a long time regarded as indisputable; subsequent observation, however, has proved it to be a product of *post-mortem* decomposition. Morgagni has been, as it were, quoted against himself; for, in treating of the causes of cataract, he suggests that the disease may originate in a deficiency of this very fluid, whereby the lens, he thinks, would become dry and opaque. His words are: ‘Tunicâ in vitulis etiam, bobusque, sive recens sive non ita recens, perforatâ, pluries animadverti illico humorem quendam aqueum prodire: quod et in homine observare visus sum, atque adeo credidi *hujus humoris secretionem prohibita*, crystallinum siccum et opacum fieri, fere ut in extracto exsiccatoque crystallino contingit.’ (*Adversaria Anatomica*, &c., Lugd. Bat. 1741, Adv. vi. p. 90.)

which the earthy constituents of the solidified lens are deposited on the capsule.

The following are mentioned among the distinguishing signs of a fluid cataract—an advance of the iris towards the cornea, caused by an increase in the bulk of the lens, attending the fluid change—and a difference in the degree of opacity in the cataract, as respects its upper and lower portions, caused by the gravitation of its denser particles. But neither of these signs can be relied upon; for in cases of fluid cataract it often happens that the iris deviates little, if at all, from a vertical plane; and the separation of the contents of the capsule into fluid and solid is seldom sufficiently complete to allow of the more solid portions gravitating in the manner described by authors.

If a fluid cataract is examined with the microscope, the lens-fibres are found in every stage of disintegration, mixed up with earthy matter and a multitude of oil-globules.

TRAUMATIC CATARACT.

The lens may lose its transparency in consequence of a blow on the eye, although the globe may not be ruptured, or the lens itself displaced from its connections; the mere shock being sometimes sufficient to affect the nutrition of the lens, and induce a gradual opacity of its whole substance.

Any penetrating wound of the lens is sure to produce cataract, and if the wound in the capsule remains open, so as to allow the superficial cells and fibres of the lens to imbibe the aqueous humour, the whole mass gradually becomes disintegrated and absorbed, so that eventually a wounded lens may wholly disappear without any surgical interference. It was a knowledge of this natural process that first suggested the operation for the cure of cataract by *solution*. It is only in exceptional cases that the whole lens becomes absorbed in consequence of a wound. More commonly it happens that a certain portion of lens-tissue remains enclosed within the capsule, and undergoes fatty change. The following is the appearance such a traumatic cataract would present some years after the occurrence of the injury.

There is probably some adhesion of the pupillary margin to the capsule, the result of old iritis; the pupil is occupied by a disk, formed by the approximation of the anterior and posterior surfaces of the capsule, enclosing between them some remains of very opaque lens-tissue. This disk is situated much

farther back than the position occupied by a full-sized lens, and its dead-white patchy area not unfrequently exhibits some glistening crystals of cholesterine.

In cases where the wound of the lens has been followed by a considerable amount of iritis, the whole margin of the pupil may be found adherent to the anterior capsule, which may also be coated with a dense membrane, composed of old lymph. The pupillary area may be small, and not susceptible of increase by the use of atropine, on account of the intimate union between the iris and the capsule. Occasionally there is a deceptive appearance of a partial opening of the pupil, and a casual or inexperienced observer will suppose that a sufficient portion of the pupil is free, so as to allow of useful vision. The supposed aperture, however, is really a patch of black pigment, lying on the whitish membrane which is closing up the pupil. Light, concentrated on the part by means of a lens, will almost always reveal the true nature of the supposed aperture, or, should this means fail, the ophthalmoscope will at once resolve the doubt.

It would be impossible to describe all the various appearances presented by the pupil after the partial or complete absorption of a wounded lens. The capsule may block up the entire space in the manner just described; it may form a delicate filmy network, hardly visible except under concentrated light; it may have been completely torn through at its centre, the peripheral portion retracting all round, so as to form a white ring, almost hidden by the iris; or it may assume the appearance of a single white band stretched across the pupil from side to side. In short, there is hardly any possible variety of figure which the opaque capsule may not assume.

It never undergoes absorption, but it often appears to do so, in consequence of the manner in which it retracts and shrinks together when divided. This retractile property of the capsule should always be borne in mind by the surgeon, in the various delicate operations which become necessary when an opaque portion of it is obstructing the pupil. He should take care not to isolate any part of the opaque membrane, but to regulate his incisions and lacerations of it in such a manner that it may always have a fixed point at the periphery, towards which it may retract, and so leave the central portion of the pupil free.

Dislocation of the lens into the anterior chamber.—This accident takes place as a result of external violence, such as a blow upon the eyeball or a violent fall. It more frequently happens when

the lens has been long in an opaque condition, and its suspensory ligament weakened, or partially detached by disease. The appearance of an opaque lens in the anterior chamber is so peculiar, that the nature of the accident can hardly be mistaken. When the lens is dislocated in a transparent state, its margin presents the appearance of a ring of golden light. Pain and inflammation set in very soon after the occurrence of the accident, and loss of the eye can be averted only by prompt removal of the lens, through a suitable opening in the cornea.

I have already spoken of certain forms of partial displacement of the lens, when treating of the inflammation such accidents give rise to (see the section, 'Traumatic Iritis,' p. 98); and have considered 'subconjunctival dislocation of the lens' in the chapter on Affections of the Sclerotic (p. 90).

TREATMENT OF CATARACT.

Before describing the treatment of cataract, I may be expected to say something respecting the morbid agencies which give origin to it. But, in truth, the causes of cataract, whether remote or proximate, have hitherto received no satisfactory explanation. The fact that the lens may be opaque at birth, or may become so in old age, at once proves under what widely different conditions the disease is developed; and we need but cast a glance at the varying and even opposite theories which have been given as to the predisposing causes of cataract, to convince ourselves they are but guesses, for the most part fanciful and unfounded.

Thus, one author thinks that persons exposed to the heat and glare of strong fires are predisposed to cataract; another makes the same remark of those who drink sour wines; by a third, the prevalence of cataract among the Turks is attributed to their using opium; while other observers consider that the inhabitants of volcanic countries are peculiarly liable to the disease. Certainly, in its senile form, cataract is common enough among our own agricultural labourers, who know nothing of sour wine, and very little of opium, are not incommoded by over-large fires, and never saw a volcano.

The truth seems to be, that, in all countries, cataract is a frequent accompaniment of advancing years; and neither social position nor peculiarity of employment exempts the aged from being liable to it.

Can cataract be cured without an operation? This question will be answered in the affirmative by hosts of quacks, who, for their own selfish ends, avail themselves of that shrinking from anything bearing the name of an operation, which is a natural instinct in us all, and pretend, by means of liniments, or drops, or the still more scientific-looking galvanic battery, to turn opaque lenses into clear ones.

It would be presumptuous and absurd to pronounce absolutely that no cure for cataract, short of a surgical operation, can *ever* become possible. But certainly nothing approaching to such a cure has hitherto been discovered.

The surgeon must constantly be on his guard against being too much impressed with the mere existence of opacity in the lens, as if it were altogether an independent disease.

Various inflammatory conditions of the eyeball may eventually produce cataract, but in such cases there are usually some signs of disease in other tissues, as well as certain peculiarities in the position or appearance of the lens itself. Old adhesions between the pupillary margin and the anterior capsule—a bulging forward against the cornea of the iris and lens, or their receding too far backwards, so as to produce an unnaturally large anterior chamber—an irregularly dilated and fixed pupil—a tremulousness of the lens whenever the recti muscles are put in action—total loss of perception of light—such are the more striking conditions which at once would lead us to institute searching inquiries into the earlier history of the case, or to regard the cataract as unsuited for operation.

It must always be remembered that simple opacity of the lens, however far advanced, never deprives a patient of perception of light, provided the retina is sound. Indeed, in the great majority of instances, a patient with no other disease in the eye but an opaque lens, will not only readily perceive the shadow of a hand, or other object, passing between him and the sky, but, with his back to the window, will perceive the light reflected from a sheet of paper, although he may be quite unable to detect the form of the reflecting surface. Many patients, with densely opaque lenses, will, in the same position, recognise well-illuminated coloured surfaces, such as bright red or yellow, or will even discriminate between yellow and white. If, in addition to this perceptive power, the iris maintains its vertical plane, the pupil is round and active, the cornea brilliant, the consistency

and movements of the globe perfect, the surgeon may regard the cataract as suitable for operative treatment.

Long experience and observation will give to the surgeon a certain empirical tact in determining whether a given case of cataract is, or is not, fitted for operation. He recognises at once the difference between an eye which has passed through inflammatory stages, and one in which simple opacity of the lens is present. In the latter case, however dense the cataract may be, the patient has a certain expression of *trying to see*, quite different from the manner of one who merely turns his eyes this way or that, at the command of the surgeon.

In all cases the pupil should be dilated with atropine before the surgeon finally resolves to operate, so that no concealed adhesion between the iris and the capsule may remain undetected.

OPERATIONS FOR CATARACT.

These may be arranged under three heads: *depression*, *solution*, and *extraction*.

1. In *depression*, or 'couching,' as it was formerly termed, the lens is thrust from its natural position in such a manner that, although still within the eye, it may allow the rays of light to pass unimpeded through the pupil to the retina.

2. The operation by *solution* or *absorption* grew out of that by depression; for it was found that if, in the attempt to depress the lens, it accidentally became much broken up, the fragments gradually dissolved and disappeared; and hence it occurred to certain thoughtful observers that this absorbent power in the system might be taken advantage of in such a manner as to avoid the dangers inseparable from the old operation of 'couching.' Hence arose *discission* or *division* of the lens, since modified into the operation by 'solution.'

3. In *extraction* the opaque lens is removed bodily out of the eye, through a wound made for that purpose in the cornea.

OPERATIONS BY DISPLACEMENT OF THE LENS.

(*Depression; Reclination.*)

Those who are interested in the early history of ophthalmic surgery will find the older descriptions of cataract, and the operation for its cure, wholly unintelligible, unless they are

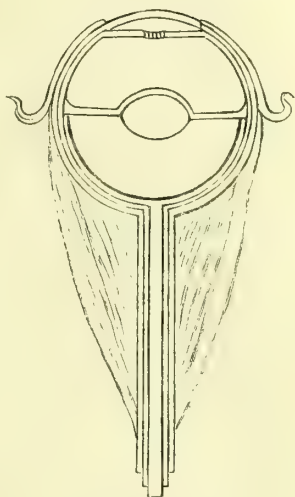
acquainted with the views of the ancients respecting the anatomy of the eye.

Even so late as the time of Vesalius it was believed that the lens occupied the exact centre of the globe, and it is so figured in that anatomist's work, *De Corporis Humani Fabricâ*, 1555, p. 798, where it is placed exactly midway between the iris and the junction of the optic nerve with the retina; the posterior chamber of the aqueous humour and the chamber of the vitreous humour being precisely of the same extent. Such a position of the parts would of course afford ample space for an opaque *humour* to collect, and form the supposed 'cataract' between the lens and the iris.

It is a curious fact that, while the operation of 'couching,' or depression, had been practised from very early times, each successive generation of surgeons firmly maintained that what they depressed was not the lens—which, indeed, they believed to be the immediate seat of vision—but a skin, or coagulated film, in front of it. Ambroise Paré, the most celebrated surgeon of his day, after describing the mode of introducing the needle through the sclerotic, and depressing the cataract, adds, 'en faisant telle chose se faut bien donner garde de toucher à l'humeur cristalin, pource que, comme nous avons dit, il est le principal instrument de la veüe.*'

It was not until the latter part of the seventeenth century that the real nature of cataract was understood; and some of the old oculists, who had passed their lives in depressing lenses without knowing it, were furious at the new-fangled theory of cataract being the opaque lens itself.†

FIG. 146.



Section of the eye as figured by Vesalius.

* *La Méthode curative des Playes*, &c. Paris, 1561.

† Thus Woolhouse, an oculist who, in spite of his gross ignorance, was the leading operator of his day, was most indignant when Brisseau, appealing, in proof of his assertion, to dissections of cataractous eyes, declared the lens to be the seat of cataract. Facts were against Woolhouse;—'tant pis pour les faits!'

The early surgeons, therefore, who, from time immemorial, had taught the operation of depression, however they may have erred in *practice*, through their ignorance of the real pathology of cataract, acted in perfect accordance with their own *theory* of its nature; for such a membrane as they believed a cataract to be, when once thrust fairly away from the pupil, would not have been likely to set up irritation. One can less readily understand how, after the real nature of cataract had become known, operators could still imitate the old manipulations, and persuade themselves that so bulky a body as the lens could be displaced in such a manner that it should not press upon, or interfere with, any of the delicate tissues surrounding it.

To pass a needle through the sclerotic, until its point arrived at the upper edge, or the front surface of the opaque lens, which was then thrust downwards, or backwards and downwards, and embedded in the vitreous humour, appeared a real triumph of surgical skill; so instantaneous was the benefit conferred by the operation, and so trifling the pain of its performance. The patient was in a moment restored to sight, and the smallness of the wound seemed to obviate all risk of inflammation. And, no doubt, depression, or the modified form of it, termed reclination, in which the lens is turned over on its posterior face, instead of being thrust vertically downwards, would be a very perfect operation, if it were possible to insure the lens being conducted to the position so neatly figured in diagrams, where it reposes in the vitreous humour, quite out of the way of the pupil, and close to, but never touching, the retina or ciliary processes.

But how is the lens to be so placed in reality? Even if the whole eyeball were as transparent as the cornea, so that the surgeon could keep the point of his needle in view throughout every stage of the operation, how could he deposit the lens precisely in the position I have mentioned? Or, if he succeeded in leaving it in the very spot he had intended, below the pupil, and yet above the retina, how could he insure its remaining there? how prevent its sinking downwards, so as to come in contact with the retina, or falling forwards against the ciliary processes and iris, where it must act as a foreign body, and set up irritation which nothing could subdue?

Depression, the oldest form of operation by displacement, was performed in the following manner. The patient was seated, and the surgeon sat facing him. An assistant, standing behind

the patient, steadied the head and raised the upper lid. The needle being thrust through the sclerotic, a little below the equator of the eye, and a short distance from the edge of the cornea, was to be carried between the iris and lens, until the point of the instrument appeared in the area of the pupil. It was thrust on as far as the upper part of the lens, which was then pressed directly downwards, until it descended below the ordinary level of the pupil. It must be evident to any one familiar with the anatomy of the eye, that a body so large as the lens could not be made to descend vertically to any considerable extent, without coming in contact with the ciliary processes; but we must remember that the old oculists performed their operations without the aid of mydriatics, so that they could press the cataract out of sight without forcing it to descend so low as would be necessary to make it disappear from an artificially-dilated pupil. Still, there can be no doubt that they frequently thrust the opaque lens either against the ciliary processes or against the retina, and hence the 'inflammation,' which was looked upon as almost a natural consequence of the operation.

To obviate the danger consequent upon depressing the lens directly downwards, the operation of *reclination* was devised, whereby the lens was pressed in a direction backwards, downwards, and a little outwards. The needle was passed on until its lance-shaped head appeared in the area of the pupil, as in the operation of depression; but the flat of the instrument was placed on the anterior face of the lens, a little above its middle, and steadily pressed against it, until the lens was forced to quit its natural position, and sink down into the vitreous humour. Here it was to be left, with its anterior surface directed upwards, its posterior surface downwards; close to, but not touching, the retina; its lower edge towards, but not in contact with, the ciliary processes; a state of things often figured in diagrams, but rarely, I should think, effected in practice.

The close approximation of the pupillary margin to the anterior capsule of the lens must render it almost impossible to pass an instrument between the two structures without wounding either one or the other of them. In fact, the capsule is usually opened, and undergoes still farther rupture in the attempt to dislodge the lens. No doubt this accidental rupture of the capsule and lens would, in some degree, obviate the dangers of the operation, inasmuch as a lens thus partially broken up would have some

chance of undergoing absorption, which would not take place if the lens, according to the idea of the operation, were displaced, still enclosed in its unbroken capsule.

If chronic change should have occurred in the suspensory ligament of the lens, the cataract enclosed in its unbroken capsule might sink at the first touch of the needle, especially if the vitreous humour had become unnaturally diffuent; but if no such changes should have taken place, the vitreous humour would offer great resistance to this reclination of the lens; and, accordingly, various plans were suggested for facilitating the reclination by certain preliminary manœuvres. It was proposed, for instance, as soon as the needle had pierced the coats of the eyeball and entered the vitreous chamber, to carry the point to the back of the lens, for the purpose of lacerating the posterior capsule; then the point was to be carried round to the anterior capsule, which was to be lacerated in a similar manner, and it was not till after this preparation that the surgeon was to displace the lens itself.

Other operators, finding that the elasticity of the healthy vitreous humour was an obstacle to the passage of the lens through it, suggested that the needle should first be passed to the spot where the lens was finally to be lodged, and that a bed should there be prepared for it by the disintegration and breaking-up of the cells of the vitreous humour; and to this bed the lens was finally to be conducted by the needle applied to its anterior surface.

Descriptions of all these manœuvres read very well; but to carry them into effect is a very different matter. It must be remembered that while the point of the needle is lacerating the posterior capsule, or making a soft place in the vitreous to receive the lens, the instrument is wholly concealed from the surgeon's view, and is within a few lines of the most delicate and important structures. What risk must there not be that, while endeavouring to break up the cells of the vitreous, or lacerate the capsule of the lens, the surgeon may all the while be tearing up the ciliary processes, or even the retina itself!

To evade the difficulty of displacing a cataract by mere pressure with the flat of the needle, some operators proposed that, instead of carrying the instrument between the iris and the anterior capsule, its point should be thrust fairly into the substance of the lens, which would then be easily displaced, and carried downwards and outwards into the vitreous humour; the

needle being disengaged by rotating it. Two difficulties, however, must attend this operation—the risk of driving the lens before the instrument in the attempt at transfixion, and of pressing the lens against the retina in endeavouring to disengage the point of the needle.

But even supposing that the surgeon succeeds perfectly in accomplishing the object he has proposed to himself, and, by depression or reclination, modified by any of the methods I have described, has displaced the cataract from the axis of vision, and sunk it in the vitreous humour, without inflicting injury either on the ciliary processes or the retina—what has he done? He has deposited a large foreign body—for as such we must regard a cataractous lens detached from its organic connections—in close proximity to the retina. How can he insure the foreign body's remaining suspended in the vitreous humour, without coming in contact with surrounding parts? Will not the vitreous cells in the immediate neighbourhood of the cataract undergo gradual disintegration, and allow it to come into contact with the retina, or fall forwards against the iris?

No doubt these would have been the almost invariable results of depression and reclination, were it not that, in the attempts to displace the lens, it very commonly became a good deal broken up; and this very accident it was which predisposed the lens, after it had been displaced, to undergo absorption. The ultimate issue, however, of most operations of displacement was sufficiently bad to justify my assertion, that it is essentially an unscientific and rough proceeding, calculated to set up a chronic state of inflammation in the deep tissues of the eye, which is in its very nature uncontrollable, inasmuch as the exciting cause, the displaced lens itself, cannot be removed.

Inexperienced persons who witnessed an operation of displacement were apt to admire the rapidity and apparent ease with which it was performed, and the immediate restoration of sight which took place; and they contrasted it, perhaps, with the extensive wound made in extraction, the accidents that occasionally attended that operation, and the slow after-progress towards useful vision. But these appearances were deceptive; every bystander could see the difficulties and mishaps that attended extraction, but in depression or reclination, if only the cataract disappeared from the pupil, everything seemed to have succeeded. The damage inflicted on deep-seated parts could not be detected, and it was only in following up the case that their result became

appreciated, in the slow and insidious changes within the globe, which, many months after the operation, terminated in utter loss of sight. In such cases it was said how well the operation succeeded—how perfectly the patient saw, till, unfortunately, inflammation set in, and, in spite of everything being done that medical skill could suggest, destroyed the sight. And why did ‘inflammation set in’? Either because structures essential to vision had been injured by some stab in the dark during the operation, or because a foreign body had been left in contact with them, to set up in due time an uncontrollable process of disorganisation.

OPERATION BY SOLUTION OR ABSORPTION.

I have said that this operation grew out of that by depression; and it is only surprising that some of the older surgeons, who had been struck by the manner in which fragments of the lens, accidentally detached during their attempts at depression, became spontaneously absorbed, did not discover that this law of absorption might be applied to the removal of the whole lens.*

* Thus Pott, writing in 1775 on the subject of depression, says: ‘When the opaque crystalline is in a state of dissolution, or the cataract is what is called perfectly soft, if the capsula of it be freely wounded by the couching-needle, the contents will immediately issue forth, and mixing with the aqueous humour will render it more or less turbid; sometimes so much so as to conceal the point of the needle and the iris of the eye from the operator. . . . The aqueous humour, however turbid it may become, will in a very short space of time be again perfectly clear; and if no disorder of the capsula of the crystalline, previous or consequential, prevents, the rays of light will pass without obstruction through the pupil, and the patient will be restored to as perfect vision as could have followed the most successful operation of either, or of any kind, in the same subject and under the same circumstances.’ He adds: ‘I have sometimes, when I have found the cataract to be of the mixed kind, not attempted depression, but have contented myself with a free laceration of the capsula; and having turned the needle round and round between my finger and thumb, within the body of the crystalline, have left all the parts in their natural situation; in which cases, I have hardly ever known them to fail of dissolving so entirely as not to leave the smallest vestige of a cataract.’ (*Chirurgical Observations*, &c. 8vo. 1775.)

Pott’s merit did not consist in being the first to observe that soft cataracts, if broken up, would wholly dissolve, but in turning an accident into a ground for a special and definite operation; thus establishing solution as a legitimate method of removing an opaque lens. Peter Kennedy, in his anonymous *Ophthalmographia*, 1713, relates how, having depressed a cataract in a woman aged twenty, he endeavoured a year later to do the same with the other cataract, which was of the ‘curdly kind.’ He adds: ‘I had no sooner touched

When this law began to be understood, surgeons fell into the mistake of supposing that the more completely the lens was broken up at first, the quicker would absorption go on; and they therefore endeavoured to cut up the whole lens into fragments, by what was termed the operation of *discission*.

The cure of cataract by solution is one of the most perfect and beautiful within the range of surgery. It is based on the law, already alluded to, that if the capsule be lacerated so as to expose the tissue of the lens itself to the macerating influence of the aqueous humour, the cells and fibres of the lens, by gradually imbibing this fluid, become broken up and dissolved; and are then so completely absorbed, that at the end of a period varying in duration according to the consistence of the lens and the absorbent power of the patient, every vestige of cataract will have disappeared. In fact, provided the patient's constitution be vigorous, and the lens be not too freely broken up at any one time, it is quite possible to effect the absorption of a cataract in an old person, even up to the age of seventy. But, inasmuch as in such persons cataract usually advances simultaneously in both eyes, the slow process of absorption is found to be wearisome and inconvenient, and liable to be interrupted by slight inflammatory attacks; and as the operation requires to be frequently repeated, the more rapid cure by extraction is to be preferred.

The leading principle to be observed in all operations for the solution of a cataract, is, not to oppress the eye with more broken-up lens-tissue than the absorbing power of the organ is capable of rapidly removing. If this rule be neglected, the numerous fragments act as so many foreign bodies; inflammation is set

it with the needle, when it broke, and mixed with the aqueous humour, which becoming *drumly*, the patient could no longer see; I then withdrew the needle, and began to doubt of the success, but I found in a month's time all settled to the bottom, and her sight became clear and well.

But similar cures by solution had been quite unintentionally performed nearly two centuries before the time of Kennedy; as the real seat of cataract, however, was at that period unknown, these accidental cures by solution led to no further improvement.

I have not seen quoted on this subject the following remarkable passage from Ambroise Paré:—‘Aucunes cataractes en les voulant abatre deviennent comme lait ou eau trouble, à raison qu’elles ne sont encore assez dures; et que telle chose adviene encore y a il esperance de guarison, pour ce que puis apres elle ne se peut rassembler, et apres quelque temps l’œil se clarifie, principalement aux jeunes.’—*La méthode curative des Playes*, &c. Paris, 1561, p. 239.

up in the iris and cornea, and then all absorption is at once arrested. The conjunctiva and sclerotic become injected; there is pain in and around the eyeball, with intolerance of light and lachrymation; the aqueous humour is turbid, and the epithelial surface of the cornea dull and uneven.

Operation on infants.—The breaking up of the lens, if carefully performed, is so devoid of danger that it should by no means be deferred on account of the tender age of the child; on the contrary, by operating early there is a greater probability of obviating those twitching movements of the globes (*nystagmus*), which so frequently attend congenital cataract. Of course, if the infant were extremely puny and ailing, affected with diarrhœa, or in any way weakened by temporary derangement of health, the operation should be deferred for a while, until the absorbent power had been restored; but it is desirable not to wait until the irritation of teething sets in.*

The needle I prefer for most of the operations on the lens has a small lance-shaped head, and the relative proportions of the head and the shaft of the instrument should be exactly such as will allow of the shaft playing with perfect freedom in the aperture which the head has made. If these proportions are not accurately preserved, and the shaft is made larger, with the view of preventing the escape of the aqueous humour, it becomes wedged in the wound, and all movements of the point are difficult and constrained. A needle of a larger size than that used for the ordinary operation on infants is very useful in breaking up the capsular obstructions which remain after the lens-tissue has become absorbed, as the head may be of such a size as to allow of its convex edges being made to cut.

All cataract operations are best performed on patients lying down. It was, I believe, at the Moorfields Hospital that this position was first adopted for all such operations, and it has

* The merit of Saunders seems to have been limited to establishing *as a rule* that congenital cataract should be operated on in early infancy. No doubt this rule is a most important one; but the extravagant praise on that account claimed for Saunders by his partial friends strikes one, at this distance of time, as quite disproportionate; and his practice of keeping the operation a secret, or at least of excluding medical men from witnessing it, would in the present day be reprobated as illiberal. One pupil, Adams (afterwards Sir William), was set apart, almost with the solemnity of a consecration, as the suffragan of Saunders, but of course the operation very soon became the common property of the profession.

since been introduced upon the Continent, where, a few years ago, patients always underwent the operation for cataract in a sitting posture. Infants are best secured by swathing them from the chin to the feet in a round-towel. An assistant steadies the head by placing a hand on each side of it; the lids are kept apart with a spring speculum, and sometimes it becomes necessary for a little fold of the conjunctiva, just beneath the cornea, to be nipped up in a forceps, so as to steady the eye. If the operator contents himself with using a single needle he can himself with the other hand use the forceps; but if he prefers a more complete laceration of the lens by the use of two needles at once, he must of course intrust the forceps to the hands of a second assistant.

And here I may observe, that the rule I have mentioned, as so important to bear in mind—namely, to avoid attempting too much at the first operation for solution, admits of an exception in the case of congenital cataract in *infants*. During the first few months of life the lens is so soft in texture—it so readily imbibes the aqueous humour, and undergoes dissolution, and the absorbent power is so active—that the lens may be freely torn up in every direction without the same risk of iritis and other inflammation, as would attend a similar disintegration of it in an older child or an adult. During the operation for solution on an infant I have frequently seen the entire lens shell out of its capsule, and slip forwards into the anterior chamber, without any inflammation taking place, the lacerated lens speedily undergoing complete absorption.

Previous to any needle-operations for cataract, the pupils should be dilated with a few drops of solution of atropine, applied an hour or so before.

The needle is to be introduced through the cornea * close to its junction with the sclerotic, and carried on until its point reaches the centre of the pupil. Then the anterior capsule is to be freely lacerated in various directions, and the body of the lens broken up, and the needle may be carefully passed quite through it, so as to lacerate the posterior capsule.

If two needles are used together, the first should be passed in

* I am assuming that all operations for solution of the lens, and for removal of capsule, are to be performed by *keratonyxis*. Formerly the needle was always passed through the sclerotic (*scleronyxis*); but the operation through the cornea, allowing, as it does, the point of the instrument being always kept in view, is evidently to be preferred.

until its point reaches the middle of the pupil, before the second one is introduced through the cornea.

In an infant with congenital cataract both eyes may be operated upon at once; but in an adult the worse eye, if there be any difference, should be operated on first, so as to leave the patient one partially useful eye, while the process of solution, with the temporary loss of sight which it involves, is going on.

After the operation both eyes should be kept closed by means of a light bandage, or strips of plaster on the eyelids, for twenty-four hours, by which time the little wounds in the cornea will have closed.

If the lens has been effectually broken up, and the infant is in good health, a few weeks will sometimes suffice to insure the absorption of the entire cataract; and the capsule, gradually retracting towards the periphery, will ultimately form a white ring almost or altogether concealed by the iris when the pupil is contracted.

But it is not always possible to effect this complete dispersion of the cataract by a single operation, and the capsule, enclosing between its layers a certain amount of unabsorbed lens-tissue, remains as a chalky-white disk, blocking up the pupil and preventing all useful sight. In such cases the two needles must again be employed, and the central portion of the opaque membrane torn through to the desired extent; or, in some cases, it may even be necessary to introduce the cannula-forceps through an opening made in the cornea, and extract the capsule entire. This latter proceeding, however, should never be resorted to if a good central opening can be effected by means of the needles only; for in spite of every precaution, the pupillary edge frequently becomes adherent to the wound made for the introduction of the forceps; or else the traction of the iris, to which the capsule often adheres, causes subsequent distortion and deformity of the pupil.

Operation on children and adults.—The cataracts which come before us in children, and in persons under thirty years of age, are very commonly those of the congenital form, which had been overlooked during the period of infancy. For it is rare to meet with instances in which cataract *begins* to be developed in childhood, or in the early years of adult life. The operation for the solution of cataracts of this kind is the same as that I have just described on the infant, with this important exception—that in the older subjects we must take care not to set

up irritation in the eye by too extensively breaking up the lens at first; least of all must we be indifferent to the risk attending the accidental displacement of the lens into the anterior chamber, an occurrence which, as I have said, may happen in the infant without any bad results.

In the first operation on an adult, the surgeon should not do more than freely break up the anterior capsule to an extent equal to the area of the pupil when not under the forced dilatation of atropine, and disintegrate the superficial portion of the lens, without disturbing the nucleus. This may be done with a single needle, the spring speculum being used or not, according to circumstances. When aided by a skilful assistant, the surgeon may often dispense with the speculum; but it is usually more convenient to employ it, and its use will enable the surgeon to perform the operation alone, if no assistant is at hand.

In using the needle, the surgeon is always to begin to act with the point upon the central portion of the lens; and in all subsequent operations he is to work from the centre, endeavouring to effect an opening in this situation quite through the lens and posterior capsule, leaving a ring-like portion of both, to be dealt with, if necessary, by a final operation with two needles.

If, instead of beginning to attack the lens at the centre, the surgeon uses the needle at random, and breaks up the lens at the circumference, he will probably set loose some portions of capsule, which will afterwards wave to and fro in the pupil, and be a most serious impediment to the final success of the case.

After the operation both eyes must be kept closed for twenty-four hours, at the end of which time the needle-wound is usually united, and the aqueous chamber refilled. From the second day it will only be necessary to close the operated eye, and after a few days a shade may be substituted, and then that may be laid aside for a pair of tinted glasses. The day after the operation atropine should be reapplied, and its use continued so long as any sclerotic zone remains, or so long as the swollen and macerated lens threatens to press upon the iris. Day by day the white flocculent lens-tissue continues to pass through the opening in the capsule; and if the pupil is not kept well dilated, so as to make room for the increasing bulk of the lens, the iris will become inflamed, and pain will be set up in the eye.

No absolute rule can be laid down as to how often and at what intervals it will be necessary to repeat the needle-operation. In exceptional cases I have known a single operation suffice for the total absorption of the lens even in an adult: and in a healthy infant, after completely breaking up the lenses, I have seen both of them wholly absorbed at the end of two months. More commonly, it is necessary in children and young persons to repeat the disintegration of the lens a second time, at an interval of some months after the first operation, and a finishing touch with the needle may subsequently be required thoroughly to clear the pupil from capsule. It is important not to be premature in performing this final operation on the capsule, for during the process of absorption it undergoes so many changes of position by shrinking, that time should be allowed for it to settle into its permanent position before the final laceration of it is made.

If, from peculiar circumstances, it be thought advisable to procure the solution of the lens in an elderly person, or in one whose power of absorption is very feeble—or in a case where the lens is of that peculiar waxy consistence which renders it so little disposed to imbibe the aqueous fluid, and become loosened up and flocculent, the surgeon must be prepared to use the needle more frequently; for, in these instances, solution proceeds at a very slow rate, only just the quantity of lens-tissue which is crumbled off at the time of the operation being absorbed, and then no advance being made until a fresh portion of the lens is dug out.

Under these conditions, it may be necessary to employ the needle every two months; and if slight attacks of inflammation occur to interrupt the process of absorption, even longer intervals must be allowed, so that a twelvemonth or more may elapse before a perfectly clear aperture through the centre of the lens is obtained.

In an adult it sometimes happens that, either on account of the lens having been too much broken up at once, or in consequence of the absorbing power having been checked by inflammation, the eye becomes oppressed by the displaced fragments of lens; the sclerotic and conjunctiva then become injected, there is intolerance of light and profuse lacrymation, the iris becomes discoloured, the aqueous humours turbid, the cornea hazy and uneven on its epithelial surface. When these symptoms set in, the eye will be lost by chronic inflammation, unless it be

forthwith relieved from the pressure of the swollen lens. The lids being separated with the spring speculum, and the globe steadied with a forceps, an incision is to be made in the cornea close to its margin, and through this a small scoop or spatula is to be introduced into the anterior chamber. The softer pulpy portion of the lens will then escape along the groove of the scoop, or by the side of the spatula when it is rotated; and if this operation has been resorted to in time, an eye which had presented all the phenomena just described may be speedily restored to a healthy state, and that portion of the lens which has been left *in situ* will steadily undergo complete solution.

When a perfectly *fluid cataract*, or one which has to a very great extent undergone the fluid change, is operated on with the needle, it almost invariably happens that distressing nausea and violent vomiting set in immediately; and in some cases I have known this state of sickness, attended with intense neuralgia, to continue for twenty-four or thirty-six hours. As soon as the capsule is punctured with the needle, a puff of creamy fluid takes place into the anterior chamber, and a farther escape of this fluid conceals the iris from view. If nothing farther is done, the distressing sickness is almost sure to set in; but if the surgeon gently withdraws his needle, and immediately introduces at the same spot a broad cutting-needle, or the point of a cataract-knife, and rotates the blade, the whole of the milky fluid is evacuated, and the sickness is wholly or to a great extent averted. The nausea is best combated by allowing the patient frequently to swallow small fragments of ice; and the neuralgia in the ophthalmic division of the fifth nerve will probably yield to the application of chloroform liniment, applied by means of lint to the forehead and temple.

Operations on opaque capsule.—It sometimes happens that, in breaking up a cataract with the needle, the anterior and posterior portions of the capsule are so effectually lacerated, that they retract sufficiently to leave the area of the pupil unobstructed; but these are exceptional cases, and usually, after the lens-tissue has been wholly absorbed, there remain some portions of opaque capsule, which must be removed before the cure can be considered complete.

Capsular obstructions are likewise met with after extraction of the lens; and it seems desirable, therefore, to defer the consideration of them until the operations of extraction have been described.

OPERATIONS OF EXTRACTION.

The solution and absorption of a cataract in an old person is an extremely slow process, partly on account of the density and impermeability of the nucleus of the lens, and partly in consequence of the diminished activity in the interchange of material which characterises the tissues of the body in old age.

A more rapid removal of the opaque lens, therefore, becomes desirable; and although special circumstances may induce the surgeon to employ the operation for solution in patients above forty, or even fifty years of age, he will find it preferable, in the majority of instances, to have recourse to extraction.

Until within the last few years, the term ‘Extraction,’ had but one meaning—the removal of a cataract through a flap wound of the cornea. But in 1855 Graefe re-introduced and modified, under the name of ‘Linear Extraction,’ an operation which had first been devised by Gibson in 1811, and at a later period he invented an entirely new operation in which, after removing a portion of iris, he drew out the cataract with a scoop.* This

FIG. 147.



scoop, first invented by Graefe in 1857, was modified by one of his assistants, and on the strength of this mere change in the shape of the instrument the whole procedure itself became universally known, not as Graefe's—which it undoubtedly was—but as Schuft's operation.† Other surgeons in Germany have modified Graefe's invention in various ways, but their operations are all substantially the same in principle as that which he originally devised.

We may group the various forms of extraction under three heads:—*Flap-Extraction*, *Rectilinear-Extraction*, and *Scoop-Extraction*.

* The woodcut is copied from a scoop made for Graefe in 1857.

† Schuft changed his name to Waldau.

FLAP EXTRACTION.

This operation, as now practised, cannot be said to have originated with any one surgeon, but has been gradually perfected from a very rude beginning. Daviel has the credit of having performed it for the first time during the earlier half of the eighteenth century; and he professed to have derived the first hint of the operation from his countryman Petit, who, in 1708, had made an opening in the cornea to give exit to a dislocated lens. But Daviel's clumsy and complicated proceeding can only be regarded as a very rough approximation to the delicate operations of the present day. He first, with a lancet, punctured the cornea near its lower edge; then he enlarged the wound with a narrow knife, blunt at the end, but cutting on each side; and, lastly, completed his incision with scissors. Other surgeons simplified the operation by making the section with a knife only; they continued, however, to do this at the lower part of the cornea, a situation very unfavourable for quick union, inasmuch as the edge of the corneal flap was liable to catch against the lower tarsus, and so become displaced. B. Bell seems to have been one of the first to suggest the practicability of the upward section; but it is difficult to say by whom this great improvement in the operation was really established. It seems to have made its way by slow degrees, commending itself to several independent operators by its evident superiority.

It is to Beer that we owe, if not the invention, at least the systematic introduction, of the knife which still bears his name, and has superseded all other instruments for making the corneal section. This, however, Beer continued to make in a downward direction.

But it was not exclusively, or chiefly, by means of improved instruments, or by greater skill in using them, that increased success in the operation of extraction was to be attained.

The astounding plan of after-treatment which so long prevailed, and the remains of which still linger among us, makes us wonder, not that so many eyes were formerly lost after extraction, but that any were saved. Low diet, carried to the verge of starvation—profuse bleeding, both general and local—active purging and mercurialisation, and long confinement to dark rooms—formed a course of discipline by which surgeons hoped to heal a wound inflicted on a structure devoid of blood-

vessels, and peculiarly liable, therefore, to slough or ulcerate whenever its vitality was lowered by any exhausting agencies. These surgeons saw the cornea die in persons worn out with scarlet-fever, erysipelas, small-pox, or typhus; and yet, in the after-treatment of extraction, they seemed bent upon reducing the patient as near as possible to the same condition as those diseases would have done.

I shall have occasion hereafter to speak of the after-treatment of cases of extraction; at present we have to consider the operation itself.

The objects to be kept in view are the following:—

To make a crescentic opening in the cornea sufficiently large to afford an easy exit to the lens. To make the incision at such a distance from the sclerotic as to insure both edges of the wound being wholly of corneal tissue: for wounds of the true cornea, provided their edges are in perfect apposition, have a peculiar readiness to unite—a property not equally shared by that extreme marginal portion of the cornea which blends with the sclerotic. Freely to lacerate the anterior capsule, so as to allow of the lens readily slipping through the rent when pressure is made on the globe. Lastly, to apply this pressure in such a manner that the lens may be made slowly to turn on its transverse axis, and thus to present its upper margin first at the pupil, and then at the corneal wound.

If we reflect, that the surgeon's object is to dislodge and press out the lens, at the same time that he avoids pressing out any portion of the vitreous body, it must be evident that extreme care and delicate handling are necessary. The pressure must be regulated with a nicety which is hardly possible unless the operator has the eyeball under his sole management. The best position for the patient, therefore, is to lie upon a high couch, with his head alone slightly raised. The surgeon, standing or sitting behind him, can then control the movements both of the upper lid and of the eyeball. Formerly the patient was always seated on a chair, the surgeon sitting opposite to him, while an assistant steadied the patient's head, and raised the upper lid. But in this way it was impossible for the patient's head to be fixed as immovably as if it were resting on a couch; nor could an assistant, however careful, regulate the pressure he made on the eyeball in exact accordance with that exerted upon it by the operator.

The chief difficulty attending the formation of a proper section

through the cornea arises from the fact that the knife has to be carried across a chamber filled with a fluid, ready to escape at the smallest opening which the blade of the instrument may leave unguarded; while the instant such an escape takes place, the elasticity of the contents of the eyeball forces the iris forwards over the edge of the instrument. The sawing motion we employ in using a scalpel, or any other kind of surgical knife, would be inadmissible in making a section of the cornea, inasmuch as each to-and-fro movement of the blade would allow of a fresh escape of aqueous humour, or would inflict a wound on the iris, when that structure had come forward to fill up the place of the lost fluid. Hence arose the necessity for a blade regularly increasing in width and thickness from the point to the heel. Such an instrument, if steadily carried on in one direction, without any rotation, completes the wound at a single thrust, while its wedge-like form prevents the premature escape of the aqueous humour, and so lessens the danger of wounding the iris.

It would be very unprofitable to enter into a description of the various cataract-knives which at different times have been invented. One operator after another has endeavoured, by alterations in the shape of the blade, to overcome the special difficulty which has most beset him; but surgeons are now pretty generally agreed that the instrument which goes by the name of Beer's* knife is, with certain modifications, the most useful, and that no merely mechanical contrivance can obviate all the difficulties attending the operation of extraction.

At the time when Beer wrote, and, indeed, long afterwards, the flap was always made at the lower part of the cornea; but the upper section has been found to possess such advantages, that the lower one has completely fallen into disuse.

The patient being placed in the manner described, the surgeon standing or sitting behind him, raises the upper lid, placing

* It seems that both Casamata and Barth had employed a knife of the same shape as Beer's, but larger. Casamata's knife, if correctly figured by Wenzel (*Manuel de l'Oculiste*, 1808), resembled Beer's in shape, although there might be some slight difference of size. Beer insists, with amusing earnestness, upon the absolute necessity of the knife being made precisely according to his pattern—so many lines long and so many broad; if people pretend to operate in his way, and yet deviate from the exact pattern he has laid before them, he will not hold himself responsible for the consequences. (*Lehre von den Augenkrankheiten*, 1817, vol. ii. p. xlv.)

his fingers against the very edge of the tarsus, so as to prevent eversion. An assistant draws the lower lid downwards, and keeps it fixed by making pressure against the malar bone. He must take especial care to do this, and not in the slightest degree to press upon the eyeball. The surgeon may control its movements by allowing the tip of one finger lightly to touch the sclerotic just above the cornea, while the other rests, as lightly, against the inner side of the globe. To do this safely requires the greatest tact and care; for, as soon as the knife has transfixed both sides of the cornea, all pressure must cease, and it ought at no time to be greater than will just suffice to enable the surgeon to make his puncture and counter-puncture with certainty. Firm pressure, kept up till the section is completed, will almost inevitably cause the lens to be violently ejected, with a gush of vitreous humour.

The point of the knife is to be introduced on the equator of the cornea, a short distance in front of its junction with the sclerotic, carried steadily across the anterior chamber, and brought out at the corresponding spot near the inner margin of the cornea. During this thrust the edge is directed towards the upper margin of the cornea, so that, when the section is completed, a semi-lunar flap results.

The surgeon must take care to give the knife a steady onward pressure, so that the blade may constantly fill up the wound it is making. If he in the least withdraws the knife or rotates it, or if he attempts too soon to cut out, instead of thrusting straight on, a jet of aqueous humour takes places at that portion of the wound which is no longer filled by the blade, and then the iris instantly folds over the edge—one of the most troublesome occurrences that can attend the operation. The utmost care, however, will not always avail to prevent the loss of aqueous humour; for so ready is the fluid to spurt out, that, if the sides of the knife be unevenly ground, sufficient space may exist between the blade and the edges of the wound to allow of the escape.

If the iris has fairly come over the edge of the knife, the surgeon may disengage it by drawing the point of one finger over the cornea, from below upwards, and then making a little pressure directly backwards. In this way the iris may be made to slip back behind the edge, and by keeping up careful pressure until the section is nearly completed, the iris may be prevented from coming forward again. It is not possible precisely to

describe this manœuvre for disengaging the iris; the pressure employed should be extremely delicate and guarded, and should be wholly taken off before the very last portion of cornea is divided.

The operator may find it impossible wholly to disengage the iris from the knife, and a portion of the upper margin of the pupil may be cut away. This of course causes a slight bleeding into the anterior chamber, which obscures a view of the parts during the next stage of the operation, but the lens usually escapes readily through the artificially enlarged pupil, and, except the deformity, no permanent bad result necessarily follows the accident. Sometimes, however, it happens that a *fold* of the iris is cut through, so that there results a hole in the iris just above the true pupil. When this occurs, the surgeon must at once divide the strip of iris between the two apertures, so as to lay them into one before he proceeds to lacerate the capsule.

As soon as the corneal flap has been completed, the upper lid is allowed gently to fall, care being taken that it does not catch against the edge of the flap and evert it; and the surgeon proceeds to the second stage of the operation—the division of the anterior capsule.

After a short pause, he again carefully raises the upper lid, without making pressure on the globe, and surveys the wound. If he has made it too small, he must at once enlarge it, by passing a short, narrow, blunt-ended knife, or the blade of a pair of scissors, under the flap, to the outer angle of the wound, and carefully dividing the cornea close along its margin, in a downward direction.

This enlargement of the original wound is always very difficult, on account of the unresisting state of the loose flap of cornea, and the irritability of the eye, which the surgeon dares not then control by pressure, for fear of prematurely displacing the lens. An able assistant, who can be trusted not to press upon the globe, may often render good service in this difficulty, by nipping up in a forceps a fold of conjunctiva, just below the cornea. Scissors curved on the edges will be found préférable to the knife for enlarging the wound. No difficulty should deter the surgeon from making the wound sufficiently large before attempting to press out the lens; for if, while the opening in the cornea is too small, pressure be made on the globe, the hyaloid membrane will probably give way, and allow a portion of the

vitreous humour to escape; and immediately the lens, instead of presenting itself at the section, sinks down into the space left by the lost humour.

When this occurs, the surgeon must at once desist from all pressure on the globe, and pass in a fine sharp hook through the now gaping wound, and through the pupil, to the hinder surface of the lens, which must be drawn out as quickly and as lightly as possible. Sometimes it is better to pass in a flat scoop instead of the hook; but, whichever instrument is employed, it must be placed *behind* the lens, which is to be kept well pressed against the cornea, otherwise it will be driven still deeper into the vitreous humour.

If the surgeon has satisfied himself that the corneal wound is sufficiently large to allow of the easy exit of the lens—and for this purpose it ought to involve nearly half the circumference of the cornea—he next proceeds to lacerate the anterior capsule. The curved needle* is slipped under the corneal flap, care being taken not to entangle the point in the iris; and when its curve is fairly in the pupil, the handle is rotated so as to bring its point against the capsule. Some writers give very precise rules as to the manner in which the capsule is to be divided. One recommends a crucial incision; another tells us to make a series of cuts crossing each other at right angles, so that the lines of incision may include a number of lozenge-shaped interspaces—a figure, one would think, rather difficult to execute within the area of the pupil, even in a motionless dead eye, and certainly not practicable upon the irritable eye of a patient under operation.

In tearing through the capsule, the surgeon should take care that the rents extend quite across the area of the pupil; and if he effects laceration to this extent, he need not trouble himself about lines of incision depicted in diagrams. The lacera-

* By a curious misnomer, this needle is commonly termed in England the 'curette.' The mistake arose from an accidental circumstance. The instrument for lacerating the capsule was originally called by the French *cystitome*; the scoop, attributed to Daviel, was called *curette*. It was found convenient to mount these two instruments on the opposite ends of the same handle; and our countrymen, forgetting the meaning of *curette*, have applied that name to the sharp cystitome instead of to the scoop. It is time that we called the things by their right names; for foreigners, in reading reports of English cases, must often have been sorely puzzled to understand how we lacerated a capsule, or transfixed a lens, with a *curette*!

tion of the capsule requires a careful eye and a light hand, otherwise the lens itself may be displaced, the capsule remaining unbroken.

The needle having been withdrawn, with due care against entangling it in the iris, the surgeon proceeds to the last act of the operation—the removal of the lens.

It is a fatal error to suppose that this removal is to be effected by main force; that the eye may be squeezed in any direction, if only it is squeezed hard enough. The real object of pressure is to make the lens first turn on its transverse axis, so that its upper edge may become tilted a little forwards. To effect this, the concavity of the scoop is laid against the lower lid—which the assistant is not to touch during this stage of the operation—and gentle pressure is to be applied through the lid against the sclerotic, a little beneath the lower margin of the cornea. With the forefinger of the hand which holds the upper lid, similar gentle pressure is made on the upper part of the globe, just above the section; and then, by a carefully-regulated alternating pressure on these two points, the lens is made slowly to turn and present its upper edge at the pupil. Coming in contact with the cornea, the edge of the lens is guided upwards, and begins to protrude at the corneal wound. It is evident that as soon as the widest part of the lens has passed through the pupil, the rest will be inclined rapidly to follow; and therefore, if the surgeon does not moderate his pressure, the lens will suddenly start forward, and will very probably be followed by a gush of vitreous humour. According to the size of the corneal wound, and the degree of superficial softening the cataract has undergone, will be the amount of soft matter the lens will leave behind in passing out of the eye. A small lens will perhaps escape entire through a large wound; while if the wound be small, and the lens bulky and much softened on its surface, a considerable quantity of lens-matter will remain in the pupil and about the lips of the wound.

Quick union of the corneal wound, upon which so much of the success of the operation depends, cannot take place if any foreign matter be allowed to remain between its edges; all soft lens-matter, therefore, which may be sticking there, must be carefully removed with the scoop. The iris, which very frequently protrudes, can be best returned to its position by means of the small spatula. It is unwise to dip again and again into the pupil with the scoop for the purpose of removing every

portion of soft lens-matter. The capsule cannot be removed by such means; and it is to this that the fragments very often adhere, and a too free use of the scoop is very likely to rupture the hyaloid membrane, and cause a gush of vitreous humour.

Provided the lips of the wound are in perfect apposition, and the iris in its proper place—which may be known by the central position of the pupil—the capsule, and any small portions of entangled lens-matter, may safely be left for future removal, after the wound is healed and all irritation passed away.

When a gush of vitreous humour takes place at the moment the lens passes, the surgeon must immediately close down the upper lid, lifting it over the wound by the eyelashes, so as to prevent the edge of the tarsus catching against the projecting flap of cornea. Any prolonged examination of the wound can only lead to fresh escape of vitreous humour. After a slight pause, the surgeon, again grasping the lashes of the upper lid, may gently raise it, just sufficiently to assure himself that the flap is not doubled down, as frequently happens. Having ascertained that this displacement has not occurred, he must be satisfied, and not wait in the expectation of seeing the wound close; for the constant tendency of the vitreous humour to escape will render any adjustment of the flap impossible. The lids must at once be closed with strips of plaster and a bandage.

Although cases in which a small quantity of vitreous humour has been lost may ultimately do well, a deformity of the pupil always remains. It is large and drawn up towards the wound, and the iris forming the upper margin of the pupil retracts, so as to disappear altogether.

In the foregoing description of the operation by extraction, I have noticed some of the accidents that are liable to occur; but there remains to be noticed one more dangerous than all others, namely, *hæmorrhage into the vitreous chamber*.

Although the corneal section may have been perfectly well made, and every due precaution taken, it sometimes happens that a gush of vitreous humour, usually of watery consistence, occurs at the moment the lens escapes through the wound. Within a few seconds, or at the end of a minute or two, the patient complains of severe pain in the eye, and blood appears oozing from between the lids. This oozing does not take place

until the whole cavity of the eyeball has become filled with blood. In some instances, the hæmorrhage sets in several hours after the operation. Some diseased condition of the deep-seated tissues must exist in all these cases—a change of structure in the vessels of the choroid, with or without serous effusion between it and the retina. I need hardly say that, in all these instances of hæmorrhage, sight is utterly lost.

A similar hæmorrhage sometimes follows the removal of staphylomatous projections of the globe. As soon as the prominent portion of the staphyloma has been cut off, the pent-up aqueous fluid and serum, and the diffuent vitreous humour, gush out at the wound; and this sudden removal of support from the enlarged choroidal vessels causes them to give way. In such cases, I have found the whole retina enveloping the large clot which had been forced out of the eyeball; a proof that the blood which had detached the retina must have had its source behind that structure, namely, from the vessels of the choroid.*

AFTER-TREATMENT OF CASES OF EXTRACTION.

The prevalent belief that all operations for cataract are likely to be followed by ‘inflammation,’ and that the great aim of the surgeon is to keep this down, is of course unqualified in the popular mind by any definite notion as to the nature of this ‘inflammation,’ why it arises, or what parts of the eye it involves; and many members of the profession, when commencing the study of eye-diseases, have equally vague conceptions of the subject. Let us, then, examine a little into what takes place in an eye after flap-extraction of cataract. We will assume that the structure of the organ, with the exception of the lens, had been in a healthy condition, and that the operation has been skilfully performed.

The cornea has been divided, by a clean cut, to the extent of half its circumference; the aqueous fluid has escaped; the lens has been gently squeezed through the pupil; the iris is in contact with the hinder surface of the cornea, the cut edges of which are in exact apposition; the concave surface of the upper lid lies against the wound, and affords it support.

Within a few hours—provided the nutrition of the patient’s

* I published two cases of this kind in the *Lancet*, 1845, p. 623.

body is in a healthy state—adhesion takes place between the cut edges of the cornea. As this adhesion becomes firm, the aqueous humour is retained; it once more fills the anterior chamber, and defends the iris from being pressed against the cornea. The slight irritation to which the iris had been subjected, by the passage of the lens through the pupil, passes off, and within a period longer or shorter, according to the constitution of the patient, the extra quantity of blood, which had been affording reparative material to unite the wound, ceases to be sent thither, and the cure is completed.

This is just what happens in accidental wounds of the cornea. If the patient be at the time in a good state of health—the wound a clean cut, unattended with contusion—with no iris or other substance interposed between its edges—and if the eye be carefully kept at rest, and defended from the action of light and other irritants—a few days suffice to heal the wound. But let a similar injury be inflicted on the eye of a person feeble from age—or of one reduced to feebleness by want—or of one alternately excited and depressed by intemperance—and suppose the first two patients to be bled and restricted to low diet, while the third continues his indulgence in alcohol—what will *then* be the result? Non-union of the wound; partial or total slough of the cornea; and morbid changes in the iris and adjacent tissues; finally, loss of the eye, as far as sight is concerned.

And now let us apply these facts to a case of extraction. If the operation has been properly conducted, and all has gone well, in the manner already described, healing of the wound is the natural result. No more blood will be sent to it than the healing-process requires; and as soon as the process is completed, the extra supply will cease.

On the other hand, if the iris has been forced into the wound, a mechanical obstacle to quick union is thereby established, and union must take place by a slower process, effused lymph agglutinating the iris to the cut edges of the cornea, and then gradually drawing them together. If vitreous humour has escaped through the wound, its edges will be kept asunder for some time, but will eventually unite by adhesion.

If quick union is prevented by these or any other causes, what good can *bleeding* do? Will it dislodge the iris from between the lips of the wound? or, when the hyaloid mem-

brane has been ruptured, will it prevent the vitreous body from protruding where it meets with the least resistance? As reasonably might we expect by bleeding to dislodge a piece of muscle that was preventing union by lying between the two ends of a fractured bone.

The pain which not unfrequently sets in a few hours after an extraction is commonly of a neuralgic kind. The patient's nervous system has been excited by anxiety about the operation itself, or its result. Bleeding is sure to increase this neuralgia; while a due supply of digestible food, a small quantity of stimulus, or a narcotic, will at once arrest the neuralgia and prevent its recurrence. And yet, only forty years ago, such doctrines as the following were taught *ex cathedra*, and are still accepted and followed by many in this country, and by a far greater number of surgeons on the Continent:—that within a few hours after the operation of extraction a quantity of blood should *always* be abstracted, *whether pain come or not*; —that ‘from four to eight hours after the operation, unless pain has come on sooner, blood is again to be drawn from a large orifice,’—and yet again, ‘if pain should come on afterwards, or continue.’ For the first five days after the operation—while the patient is being drained of blood in this manner—his diet is to consist of ‘nothing but gruel, tea, arrowroot, and panada.’*

Extraction of cataract is an operation performed on those who are past the middle period of life, and one naturally expects to find among them many of those conditions of feebleness and impaired function which are incident to old age. No doubt cases occur of an opposite kind, in which the patients are plethoric, over-fed, over-stimulated with alcohol. They require to be ‘toned down,’ and their circulation brought into a more healthy state. But then this should be done by regulating their plan of living for several months *before* the operation is performed; not by bleeding them just *after*, and thus placing them in a new and unnatural condition at a period so critical.

The profession is chiefly indebted to the late Frederick Tyrrell for the introduction of a more rational and simple method of treating patients after extraction and other operations on the

* Guthrie, *Lectures on the Operative Surgery of the Eye*, 2nd edit. 1827, p. 347.

eye; although he did not so completely abandon bleeding as I am convinced he would have done had he been spared to acquire firmer faith in the *vis medicatrix naturæ*.*

As soon as an operation of extraction has been completed, and the surgeon has satisfied himself that the flap is in a proper position, he should at once close the eye, without permitting any such trials of the patient's sight as may safely be made after the removal of opaque capsule, or the formation of an artificial pupil. Such trials, immediately after extraction, are more likely to disappoint than to satisfy the patient; for when the media of the eye have just been disturbed, and the pupil is still encumbered with shreds of capsule, and perhaps fragments of lens also, objects must necessarily appear to the patient distorted and confused; whilst the opening and shutting of the lids is liable to displace the corneal flap. An assurance from the surgeon that all has gone well, and that, to restore good sight, time and patience only are needed, will effect much more towards tranquillising the patient than any premature experiments.

Both eyes are to be covered with pieces of folded linen, which are kept in place by a light bandage passing around the head. Some surgeons apply strips of plaster across the lids, instead of a bandage; but I prefer the latter, as it effectually excludes light, and therefore does away with the necessity for darkening the room, while it affords to the patient a sense of security and protection. Liebreich's bandage is a great improvement on the old linen blinkers and roller; for it always keeps in place, and can be unfastened without moving the patient's head. A little square of linen is laid upon the closed lids, and over this a little pile of cotton-wool, and the whole is then fastened down with the knitted bandage.

For some hours after the operation the patient should remain on the couch, comfortably supported with pillows. When in bed the best position is on the back; but this is by no means to be insisted on if it becomes irksome, or makes the patient wakeful. That position is the best which is the most comfortable, and likely to induce sleep.

A narcotic is sometimes needed on the first night; and in some persons, especially those accustomed to opiates, it may

* For much valuable information on this subject, consult vol. ii. of his *Practical Work*, &c.

require to be repeated for several nights in succession; but such cases form the exception, not the rule. Loss of appetite is so apt to follow the use of these drugs, that they should never be given without manifest necessity. I always prefer tincture of hyoscyamus to opium, as being far less likely to cause discomfort the next day or to confine the bowels.

The patient is of course to be thoroughly waited upon, so as to be spared every unnecessary movement or exertion. Tapes passed round the wrists and attached to the sides of the bedstead are a useful check upon sudden movements of the hands during sleep.

A moderate dose of opening medicine, given a day or two before the operation, will obviate the necessity for teasing the patient with purgatives during the first few days succeeding it. Old and feeble persons, especially those with any heart-disease, are sometimes seriously prostrated by being purged on the second or third day after the operation, just when it is so important that the healing process should be steadily advancing.

As regards diet, patients should not be deterred from taking a nutritious meal a suitable time before the operation; and a moderate quantity of easily-digested animal food should be given on each following day. In respect of stimulants, it is impossible to lay down any absolute rule. Those accustomed to take wine, beer, or spirits, must by no means be wholly debarred from them at a time when the nutrient power of the body is called upon to form new material for repairing a breach of surface. In short, the surgeon's object must be carefully to regulate both food and stimulants according to the patient's previous habits; neither keeping him too high nor too low, but as near as possible up to the ordinary level of healthy vigour.

The daily cleansing of the lids requires caution; the object not being to prevent the eyelashes sticking together, for their agglutination forms the best safeguard against the patient prematurely opening the eye. The lower lid and cheek are to be cleansed with warm water, but the upper lid is on no account to be touched, for under its shelter lies the corneal wound, sudden pressure on which would induce great suffering, and might even cause the slightly-formed adhesion of the flap to give way.

The progress of the wound towards healing is to be judged of by the condition of the lid, and the quality of the secretion. If

the patient complains only of an occasional pricking, or a sensation of grit; and if this can be traced to the slight involuntary movements of the wound against the lid; if this uneasiness subsides day by day; if the secretion consists of tears alone, or is mixed with a little of the natural conjunctival mucus; and if the skin of the upper eyelid retains its healthy appearance, and is free from redness and swelling—the surgeon may entertain the best hopes that a good union is going on.

An increased feeling of grit in the eye, coming on after the lapse of three or four days, and perhaps attended with neuralgia, would lead the surgeon to suspect that the section had yielded, and that *prolapsus iridis* had occurred.

The most unfavourable sign is a bright redness and a swelling of the upper lid, which sometimes appear on the second or third day after the operation, attended with a yellow puriform discharge. These appearances are commonly ushered in by a restless night, with headache and considerable depression both of body and mind. When the lid is raised, the ocular conjunctiva is found injected, and so cedematous that it overlaps the corneal margin (*chemosis*). The cornea itself is throughout yellow and opaque, so that no trace of iris can be discerned through it; the wound is gaping, and filled with bulging iris. Eventually the whole cornea softens, the flap sloughs, and the eyeball shrinks.

I have now and then seen this hopeless state of things come on after an operation, which had been perfectly well performed, and when the surgeon had every reason to expect a most successful result. In such cases there has probably been some degeneration of tissue in the vessels supplying the globe, and a weak condition of the heart itself.

The time that should be allowed to elapse after the operation, before the eye is examined, may vary according to circumstances. In a healthy patient, when there has been no pain in the eye, or other bad symptom, the wound may be found perfectly united as early as the third day after the operation. But, as a rule, the fourth day is quite soon enough for an examination; and whenever there has been any loss of vitreous humour, so that the healing process has been retarded, the fifth will be the earliest day on which the eye can be prudently exposed. Indeed, in an old or feeble person, a wound which on the fourth day is going on well, will be all the better for another day of rest; and it often happens that a premature exposure sets up irritation,

and, if the union be not firm, favours the subsequent yielding of the wound and prolapse of the iris.

If redness of the upper lid, attended with puriform discharge, comes on within the first two or three days, the surgeon should examine the eye just so far as to obtain a view of the lower part of the cornea, and ascertain whether it is becoming infiltrated with pus; and this may be done without exposing the wound itself.

It would be impossible to detail all the appearances which an eye may present when first examined after the operation; but it may be useful to describe some of the leading points which present themselves, both in favourable and in unfavourable cases.

1. The cornea may be transparent, with the exception of a little hazy line along the edge of the wound; the aqueous humour may have been resecreted, and the plane of the iris vertical; the pupil being either clear and black, or filled with a flocculent mass of capsule and lens-matter, accordingly as the lens has come out clean, through a large wound, or has rubbed off some of its soft cortical substance in passing through a small one. Vision may extend to the recognition of large objects, such as the fingers of a hand; or, in consequence of the obstruction still remaining in the pupil, may be limited to mere perception of direct or reflected light. Some little redness of the sclerotic and conjunctiva will of course be present in every case, an additional supply of blood having been sent to repair the corneal wound.

The appearances above described are most satisfactory, and would encourage the surgeon to look forward to a successful result.

2. The eye may present all the foregoing appearances, with the exception of the iris being in contact with the hinder surface of the cornea. This absence of anterior chamber arises from one or other of the following causes: either the wound, although sufficiently united to keep the cornea in its proper curve, has not become so consolidated as to be perfectly watertight, and the aqueous humour therefore escapes as fast as it is formed; or else this fluid, which seems to be chiefly secreted in the posterior aqueous chamber, may be so pent up there by the lens-matter filling the pupil, as to thrust the whole iris forwards against the cornea. In the former case, by keeping the eye closed for two or three days longer, and giving the patient a

little more stimulus or tonic, the wound will become consolidated. In the other case, the iris will slowly recede as the lens-matter in the pupil becomes absorbed, but perhaps will not quite resume its vertical position until the capsule at a later period shall have been broken through with a needle.

It occasionally happens that although the corneal wound, when examined on the fourth or fifth day, appears well united, it subsequently gives way a little at some point, and allows a small portion of the iris to protrude, so as to cause slight displacement of the pupil.

3. The eye may be found in the following state: the cornea clear, the section gaping, and blocked up with iris, the latter having prolapsed into the wound, after being adjusted at the operation, and no union between the two structures having occurred, in consequence of the feeble condition of the patient. In these cases the parts on the fourth day after the operation may appear almost as if the wound had been just inflicted. Chronic inflammation is sure to be set up, and is often attended with neuralgia. In non-union of this kind, it is sometimes good practice to keep the eye uninterruptedly closed for five or six days after the first examination, provided the healthy appearance of the lids, and the absence of puriform secretion, give assurance that the healing process is advancing.

4. Still more unfavourable than the appearances above described are the following: in addition to a gaping section and prolapsus iridis, a cornea hazy throughout, so that the iris cannot be clearly discerned; the edges of the wound thickened, opaque, and creamy-looking; the sub-conjunctival tissue infiltrated with serum, and the conjunctiva itself reddened and elevated (*chemosis*).

These local changes have usually been ushered in with pain in the eye and head, restlessness, and depression. Extreme care is necessary to treat a patient under such circumstances. Narcotics will probably be required at night; of these hyoscyamus is the best, and bark and ammonia are almost sure to render good service in keeping up the appetite and restoring vigour to the flagging circulation. The diet will require the most careful management, so as to insure a sufficiency of nourishment being taken without oppressing the stomach; above all, the regulation of the supply of stimulants—wine or beer—will demand much judgment on the part of the surgeon, so that the patient's powers may be raised and sustained, without causing irritability

and subsequent depression. But it will sometimes happen, in spite of care and skill, that such cases as these will terminate in closure of the pupil, with wasting and softening of the whole globe.

Although it is so important, after the operation of extraction, to defend the patient from strong light for several days, there is no necessity for closing shutters, and drawing curtains closely round the bed, if the patient's eyes have been bandaged in the manner I have described. Very moderate shading of the room is then sufficient, and thorough ventilation is most beneficial; for due aeration of the patient's blood is essential to the healing process.

Prolapsus iridis.—If the corneal section, instead of uniting by adhesion, has undergone that slower process of closure which takes place when a portion of iris is interposed between the edges of the wound, the *prolapsus* continues for some time to be a source of irritation. It should not, however, be too hastily interfered with; for, in healthy subjects, it usually wastes and flattens down by slow degrees. Sometimes, however, instead of diminishing in this manner, it becomes distended into a little vesicle, in consequence of the accumulation of aqueous humour behind it. If the prolapsus fills up nearly the whole extent of the wound, the corneal flap may be tilted forward in such a manner as to form an obtuse angle with the lower portion, the base of the flap being marked by a transverse crease, extending quite across the cornea from one angle of the wound to the other. As the process of contraction in the prolapsed iris goes on, the edges of the corneal wound are gradually drawn together, the transverse crease disappears, and the natural curve of the cornea is eventually restored.

If, however, instead of diminishing, the prolapsus remains as a large and prominent vesicular projection several weeks after the operation, means must be taken to induce it to contract. In many cases it is sufficient to puncture it with a broad needle, and, when the aqueous humour distending it has escaped, to touch the collapsed iris very lightly with a point of nitrate of silver. The eye must then be kept closed for a day or two. Should the prominence reappear, the application of the nitrate of silver may require to be repeated; but it must never be used except with a light hand, a single touch being sufficient to whiten the surface.

Fistulous wound.—If a case be not well watched for several

months after the operation of extraction, the wound may become fistulous. This is an extremely rare occurrence; so rare, indeed, as to be unnoticed by most of the authors on ophthalmic surgery. On this account, I will relate two cases which occurred under my own observation. In the first case, I could not quite satisfy myself as to whether the fistula resulted wholly from defective repair of the original wound made in extraction, or whether it was the consequence of a puncture I made in a very troublesome vesicular prolapsus.

In the second case, the prolapsed iris gave way spontaneously, many months after extraction, when the cure might have been considered complete.

1. Captain G., aged seventy-six, was operated on by extraction in the right eye, November 18, 1854. Nothing untoward occurred during the operation, and although a small portion of iris subsequently prolapsed into the wound, there was every reason to expect that its contraction and solidification would take place in the usual manner. By the end of the month, however, the prolapsus, instead of flattening down, became distended at one spot into a little vesicle. Meantime the pupil had of course become somewhat drawn upwards, and it was also obscured by a hazy condition of the flap; the lower half of the cornea always retaining its perfect transparency. On January 19, 1855, the vesicle still existed, and the anterior chamber had never been restored since the operation, the iris lying in contact with the cornea. It appeared to me, therefore, that at some part of the cicatrix a minute aperture must exist which allowed the aqueous humour slowly to exude. I punctured the vesicle with a cutting-needle, and touched the collapsed surface with a fine point of nitrate of silver. Three days later, I again touched it in the same manner. After a time the vesicle again became prominent; and on February 1, by the aid of a lens, I distinctly recognised the existence of a fistulous opening at its summit. The aperture was as minute as the section of a human hair, but pressure on the globe caused an escape of aqueous fluid to be distinctly perceived. I now coated a fine hair-like probe with a thin film of nitrate of silver, passed it quite into the minute fistulous track, and then kept the eye closed for several days. Meantime the patient's diet and allowance of stimulants, which had been liberal from the first, were increased. March 12, the vesicle had flattened down, but slight oozing from the fistula still continued. Nitrate of silver on the fine probe was twice repeated, at an interval of some days. By the end of May, the cicatrix of the wound was quite flat, but a very slight oozing of aqueous humour still continued; so slight, indeed, that some little accumulation took place in the anterior chamber, so that the iris and cornea, although very close together, were not in actual contact.

It was now evident that it would eventually be necessary to draw the pupil downwards, from behind the hazy portion of cornea adjoining the cicatrix, and so bring it opposite the clear portion below. But of what avail would this be, unless the fistula could be closed? It appeared to me, that by at once performing this displacement of the pupil, a double object might be attained, and that the wound made at the lower part of the cornea would for a time effectually drain off the aqueous humour, diverting it altogether from the fistula, which

would thus be placed in a condition favourable to closure. Accordingly, on May 30, I made an opening at the lower part of the cornea with a broad needle; caught the lower edge of the pupil with a blunt hook, and drew out and cut off a very small portion of iris. An excellent pupil resulted. Ten days after the operation, I was much pleased to find the fistula closed and the aqueous humour completely retained, and this after a lapse of more than six months from the performance of extraction. Two years later, the patient was still enjoying excellent vision, both for far and near objects, reading the editorial articles in the *Times* with a glass of two inches and a half focus.

In the foregoing case I had been induced, by special considerations, to perform extraction at a very late period of the year; and the winter, which soon afterwards set in, was unusually cold and protracted. It will long be remembered as the terribly severe winter of the Crimean campaign. No doubt the low temperature contributed to lessen the reparative power of so old a person; and the long continuance of frost and cutting winds, which kept him confined to the house till May, deprived him of the invigorating influence of exposure to the open air.

2. An elderly woman, from whose left eye I had extracted a cataract in 1857, came to me two years afterwards, complaining that the sight of this eye, which had been very good ever since the operation, had within a few weeks begun to fail. On carefully examining the eye, I observed that near the middle of the cicatrix, which was rather broad in consequence of some slight prolapsus iridis having followed the operation, there was a minute fistula, through which the aqueous humour was slowly oozing. The anterior chamber was nearly full, and the plane of the iris almost vertical, the escape through the very minute aperture being counterbalanced by the secretion of fresh fluid. The fistula was so minute that it might easily have escaped notice, and it was only by absorbing the moisture adjacent to it with a bit of blotting-paper, and protecting it from the trickling-down of the tears, that the welling-up of the aqueous humour could be positively demonstrated. I had no doubt that this fistula was of very recent formation, for otherwise the patient would not have enjoyed such good sight as had existed until within a few weeks of her coming to me. Probably the cicatrix had always been thin and tense, and now from some accidental cause it had given way at the weakest point.

At first I tried the effect of touching the fistulous orifice with a fine probe coated with nitrate of silver. This was done twice, and for a few days after the second application it appeared to have been successful; but again the little channel opened itself. I then made a counter-puncture with a broad needle at the lower part of the cornea, and let out the aqueous humour, having just before again introduced the fine probe coated with nitrate of silver into the fistulous orifice. The lids were kept in contact with strips of plaster. A week later the fistula was completely closed, and sight was improving.*

These fistulæ of the cornea are likely to be overlooked, on account of their extreme minuteness; for their aperture is sometimes no larger than the section of a human hair, and the quantity of fluid oozing out is small in proportion. The fistula

* This case was reported in the *Medical Times and Gazette* for August 27, 1859.

of course allows a constant escape of aqueous humour, and the anterior chamber becomes obliterated, the iris lying in contact with the cornea. This drain of aqueous humour, if unchecked, seems to exert some peculiarly exhausting influence upon the eye, for in all the cases I have seen in which fistulæ of the cornea had existed for several years, all useful vision had become extinct.

There are certain points connected with the operation of flap extraction which may seem to have required notice before the operation itself was described; but it appeared preferable to reserve them for later consideration, because they can be properly appreciated by those only who have already made themselves acquainted with the details of the operation.

Inasmuch as extraction is performed upon persons more or less aged, it must often happen that the constitution of such patients has been damaged by various forms of acute or chronic disease before they come under our care as the subjects of cataract; so that we cannot expect to find them by any means in as favourable a condition for undergoing an operation as those whom we are in the habit of treating for many other surgical affections. There are, however, certain conditions which would either wholly contra-indicate extraction of cataract, or would cause us to undertake the operation only after the most careful preliminary examination, and unusual precautions against the more pressing difficulties of the case.

1. Extensive heart-disease is of all complications the most unfavourable; for, by enfeebling the supply of blood to the peripheral tissues of the body, it lessens the probability of a quick union of the corneal wound.

2. Violent cough, if occurring in suffocative paroxysms, would also greatly imperil the success of the operation; partly by the unavoidable restlessness and frequent change of posture, and partly by the straining and shaking of the eye, which may disturb the wound, and induce prolapsus of the iris.

3. Fat and flabby persons have much less reparative power than those who are thin. Dry and wrinkled, but still vigorous old people—such as are popularly termed ‘wiry’—are of all others the best adapted to undergo extraction.

4. Certain morbid conditions tend to render the operation in various ways difficult, although they by no means forbid its performance. Total deafness, and deaf-dumbness, for instance, in

a great measure remove the patient from control ; but I have successfully operated on patients under both these disadvantages.

5. Mere old age does not contra-indicate extraction ; for one occasionally meets with persons of advanced years whose bodily functions are performed with surprising regularity.* Commonly, however, the reparative power of the cornea is impaired after seventy.

6. If cataract is equally advanced in both eyes, and both appear equally well suited for operation, ought we to extract both lenses at one sitting ? On this question much difference of opinion exists. My own judgment is decidedly in favour of operating on one eye only at a time. We learn much by watching the progress of a case after operation, and often see how, by this or that precaution, or course of treatment, a difficulty or a bad result might have been avoided. We operate, for instance, on a depressible patient during very hot weather, and find him utterly overcome and prostrated by it, perhaps to such an extent as to induce non-union of the wound, or even partial slough of the cornea. Were this to occur after we had operated on one eye only, we should learn experience by the result, and take care to select a cooler season of the year for operating on the other eye.

Or our patient may have deceived us as to his previous habits. He may for years have been accustomed to take large quantities of stimulants, and our first operation may have failed because we had not kept up his reparative powers sufficiently by artificial aids. Having learned the truth, too late to save the first eye, we might be able, by adopting a different plan of after-treatment, to save the second.

Without unnecessarily multiplying illustrations, I may say that by operating on one eye at a time we secure to ourselves the advantage of making our first operation a means of invaluable instruction with respect to the second ; while, at the same time, the effort of nature in repairing a single corneal wound is of course less than is required for the repair of a second wound of equal extent.

* Such was the case with a gentleman of eighty-six, upon whom I operated by extraction. I could really detect in him no organic defect whatever, and he lived six years after the operation, in the enjoyment of excellent health and good sight. He then suddenly fell ill, became jaundiced, and died after a few days' confinement to his bed.

7. Ought we to operate when cataract is fully formed in one eye, while the other is either free from cataract, or only slightly impaired by its existence in an early stage?

Exceptional circumstances may make it desirable in such a case to operate on the cataractous eye; but in the great majority of cases it will be proper to wait until cataract is fully established in the other. Of course, after the extraction of the crystalline lens, a convex glass becomes necessary, to compensate for that portion of the optical apparatus of the organ which has been taken away; and it is almost, if not quite, impossible so to adjust any mechanical aids as to make the operated and the unoperated eye work well together. Each eye, taken separately, may be good; but there is a want of harmony between them which can never be reconciled.

8. The last question to be considered is, whether any particular time of the year is to be preferred for the performance of extraction? As far as the mere operation itself is concerned, I know of no period being positively contra-indicated, except the extremes of hot and cold weather. Severe cold acts unfavourably on old people by retarding the circulation of blood in their capillaries; while extreme heat enfeebles the action of the heart, especially when it happens—as is so common in old age—that some organic change has already taken place in it. The only time which I systematically avoid for performing extraction is during that sultry weather which sometimes visits us in July and August.

But one has to consider not merely the operation itself; the period of complete repair and convalescence is equally important. It is of the utmost consequence that a patient who has gone through the confinement and the mental anxiety inseparable from so important an operation as that for cataract, should at the earliest possible period enjoy the invigorating influence of change of air; and nothing tends so much to prolong that condition of chronic ophthalmia, which sometimes follows extraction, as too long a confinement to the sick-room. A few days of careful exposure to the fresh air during genial weather equally improves the eye and the patient's general health. It is, therefore, of importance so to time the operation that the period of convalescence may coincide with the finer season of the year; and this can only be done by choosing the spring and early summer for the operation: April, May, and June are, therefore, the best months to select for extraction, although the later

summer months may be chosen, provided the weather be not sultry and oppressive.

RECTILINEAR EXTRACTION.*

This operation is, as I have already observed, a modification of that invented by Gibson.† He advised that *soft* cataracts should be freely broken up with a needle, and that after inflammation had subsided—in three or four weeks—a small incision should be made in the cornea, and the broken-up lens removed with a scoop. As the true principles which regulate absorption of a cataract in its natural position, when its tissue has been carefully broken into with a needle, became better understood, Gibson's operation fell into disuse. The fallacy of his procedure was revealed by the words 'after inflammation had subsided.' If by breaking up all the lens at once inflammation was set up, the proper practice would have been at once to evacuate the lens-matter which was the cause of the inflammation. Either do this, or adopt the slower, but safe course of only disintegrating the lens sufficiently to induce the absorbing process, without throwing the bulk of it into the anterior chamber all at once.

Graefe's operation ‡ was the following. After having dilated the pupil with atropine, he made a straight vertical incision, two, two and a half, or three lines long, through the cornea, not at its margin, but about a line nearer its centre. Such a 'linear' wound, he remarked, would heal more readily than a flap wound, and would involve less risk of *prolapsus iridis*. But, on the other hand, a rectilinear wound does not gape, and it therefore requires more manipulation to evacuate the pulpy lens-matter. Through the wound he passed in a small fleam-shaped cystitome, and with it broke up the capsule and the substance of the softened lens. Then a scoop was introduced into the midst of the pulpy mass, the wound was made to gape, by pressing the instrument against its edge, and the broken-up lens-matter escaped along the groove.

'Linear extraction' was not proposed by Graefe as a substitute

* I have taken the liberty of using the word 'rectilinear,' instead of 'linear' (the term by which Graefe designated his operation), because the wound made in the cornea is a straight one, in contradistinction to that of a flap extraction, which also forms a line, but a curved one.

† *Practical Observations on an Artificial Pupil, with remarks on the Extraction of Soft Cataracts*, 1811.

‡ *Archiv für Ophthalmologie*, ii. 217, 1855.

for the older flap operation. He considered it to be specially suitable to cases of fluid lens, the corneal wound being made about two lines long; or when the lens was almost of a pulpy consistence, rather a longer incision being then required. When the lens had retained the normal consistence of adult life, and still more when in old age it had acquired increased hardness, he considered the operation contra-indicated.

In consequence of these limitations of the operation being disregarded, and its being applied to cases of firm cataract, it soon fell into discredit. I knew of many eyes being lost after linear extraction which, from the skill of the operators, I have no doubt would have been saved if treated by them on the slow but safe plan of solution *in situ*, or by flap extraction.

Removal of cataract by suction.—In 1847 Laugier announced a quick and easy method of removing softened cataracts by suction; ‘*par aspiration*,’ as he termed it. He thrust a sort of cannula through the sclerotic into the substance of the lens, and then professed to draw out the contents of the capsule by means of a piston.* A less dangerous mode of operating was soon afterwards proposed by Blanchet, who employed a cannula and syringe somewhat similar to Laugier’s, but with the much safer modification of introducing the cannula through a wound in the cornea. Suction fell into disuse, until it was revived, under a much more delicate and skilful form, by Teale,† in 1863. With two needles he tore up the capsule; then made a small wound in the cornea, through which he introduced a flattened cannula, or curette, into the body of the lens. A flexible tube attached to the curette terminated at the other end in a mouth-piece, and the operator gently sucked out the softened lens-matter. A syringe has sometimes been substituted for the tube. The reader will at once see that this must needs be a very delicate proceeding, and that if a too great power of suction be employed, serious mischief to various tissues of the eye may ensue.

* *Annales d’Oculistique*, vol. xvii. p. 29. Laugier’s operation gave occasion to a paper war, which soon grew into formidable proportions. First he was charged with having plagiarised his operation from some Italian surgeon; then an angry combatant declared that the Italian was himself but a plagiarist, and had been anticipated by the Arabians of the middle ages. Overlooking the fact that the Arabians did not know what a cataract was, nor where it was, their modern champion quoted Arabic and even Hebrew to prove their claims to priority of discovery. (See *Annales*, vols. xvii. xviii. xx. and xxiv.)

† *Ophthalmic Hospital Reports*, vol. iv. p. 197.

However applicable to the cataracts of adults suction may prove to be, it is quite uncalled for in the congenital cataracts of infants. As I have already observed (p. 171) a lens freely broken up, and even to a considerable extent displaced into the anterior chamber, does not at that early age set up irritation; and in a few months every trace becomes absorbed and disappears.

SCOOP EXTRACTION.

In many cases of cataract it is impossible to determine absolutely to what extent the softening process may have extended, and what amount of hard nucleus may still remain. It often happened, therefore, that the surgeon who had commenced the rectilinear operation in the belief that the whole lens was pulpy, found himself embarrassed by a firm nucleus of considerable size. The removal of this mass required so much mechanical interference, that the iris became bruised and injured, and also fragments of lens might remain behind the iris and set up the most serious irritation. These and other complications seem to have led Graefe to devise a mode of operation whereby the iris might be saved from injurious pressure, and at the same time additional room might be made for removing even a firm nucleus through a corneal wound smaller than that made in an ordinary flap extraction. The result of these attempts was the operation of scoop extraction.

And here I would observe that, whatever may be the final verdict which, after more extended experience, may await the operation of scoop extraction, its invention is wholly due to Graefe, who to a great degree has been deprived of the merit of having originated it.*

There is no doubt that one of the chief causes of failure after a well-performed flap extraction, is the occurrence of prolapsus iridis, and by the iridectomy proposed by Graefe all possibility of this was of course avoided. At the same time ample room was made for the removal of a large and solid nucleus, and through a less gaping wound than the crescentic incision of flap extraction. By the use of a scoop to draw out the nucleus, all pressure on the globe was rendered unnecessary.

Scoop extraction seems most suitable to those cataracts which

* The operation was very fully described by him in the fifth volume of the *Archiv für Ophthalmologie*, pp. 158-173, 1859.

are in an intermediate condition between the semi-fluid state which admits of a complete evacuation through a rectilinear incision, and the hardness of those in which little or no superficial change has taken place.

From the diminished risk of escape of vitreous humour, during scoop extraction, in consequence of the smaller corneal wound and the absence of pressure on the globe, the vomiting which so often follows the use of chloroform is of less consequence than in flap extraction; and therefore it may be administered in operations with the scoop, although in very quiet patients it may not be necessary.

The lids being well separated with a spring speculum, the surgeon fixes the globe, by nipping up a fold of ocular conjunctiva below the cornea. He then passes in a lance-knife at the upper edge of the cornea close to its junction with the sclerotic.* Next a forceps is passed in at the wound, a portion of iris seized, drawn out, and cut off. The cystitome is then used to lacerate the anterior capsule, which should be done to the full extent of the now enlarged pupil. Lastly, the scoop is insinuated behind the upper edge of the nucleus, and carried on until the beak of the instrument has passed just beyond the lower edge. The entire nucleus is then gently drawn out.

This sliding of the scoop behind the lens is the act of the operation which requires the most care, for by rudely thrusting the instrument too much backwards, its point might be made to break through into the vitreous humour. The surgeon must bear in mind the convexity of the hinder face of the lens, and give to the beak of the scoop a corresponding curved sweep.

It will depend upon the degree of softening which the surface of the lens has undergone, how much pulpy lens-matter will remain behind after the nucleus has been drawn out. As much of this pulp as can be got away without risk of breaking into the vitreous humour should be removed; but provided no solid nodules remain, the surgeon need not be over anxious to get out every particle of soft matter. Each re-introduction of the scoop, tends in some degree to irritate the edges of the corneal wound, and there is always the risk I have adverted to of breaking through with the instrument into the vitreous humour.

* In his first description of the operation, Graefe advised that the cornea should be incised at its outer edge; but the deformity, and other disadvantages resulting from an over large and misshapen pupil, are better obviated by making the incision upwards.

The corneal incision being left clear of any lens-matter, the bandage may be applied over both eyes, as after flap extraction.

On examining the eye for the first time, the surgeon will sometimes find that the whole, or nearly the whole, of the enlarged pupil is filled with a flocculent or pulpy mass; but provided the wound be united, and the cornea clear, this obstruction of the pupil need not disquiet him. All will in time become absorbed, or if any considerable quantity should eventually remain, it may be cleared away by the aid of two needles, used in the manner hereafter described.

In most cases the softened periphery of the lens is sufficiently opaque to be readily seen at the time of the operation; but it is sometimes so nearly transparent as to be very difficult of detection, and it only becomes opaque and strikingly visible two or three days afterwards.

Although, from what I have said, it will be seen that the two great accidents which attend or follow flap extraction, loss of vitreous humour and prolapsus iridis, may be evaded by a carefully performed scoop operation, let not the reader suppose that the latter mode is to be regarded as 'extraction made easy,' or that success is always to be looked for. Cases occur in which, after the most careful scoop extraction, infiltration and softening of the cornea take place; or a more chronic form of irritation ends in permanent opacity of a large portion.

Graefe's scoop operation with iridectomy has undergone several modifications. One consists in first performing iridectomy, then waiting till the corneal wound is healed, and the anterior chamber restored; and then, by a second operation, removing the cataract with the scoop.

Another modification is as follows. A crescentic incision of the cornea is made, and the lens removed, as in ordinary flap extraction. A forceps being then passed in at the wound, the iris is seized, drawn out, and cut off, just as in the operation for glaucoma; the whole being done while the patient is under chloroform.*

* As much of the success of the scoop operation depends on the form of the instrument itself, I must bear testimony to the superiority of that invented by Mr. Critchett, to which he has given the name of 'vectis.' (*Ophthalmic Hospital Reports*, iv. 315, 1865.)

MODIFIED FLAP EXTRACTION.

This operation, the latest form of extraction that has emanated from the fertile invention of Graefe, has hardly yet acquired a settled name. It is frequently called 'modified linear extraction;' but inasmuch as a considerable incision is made in the cornea, and the lens is brought out entire, by being pressed through the wound, the procedure certainly bears more resemblance to a flap extraction than either to the 'linear' or the 'scoop' modification.

The patient is brought under the influence of chloroform; the lids are separated with a speculum; and the eyeball is steadied by nipping up with a forceps a fold of conjunctiva below the cornea. The knife, which is long and very narrow, is made to pierce the sclerotic at about the distance of a third of a line from its junction with the upper and outer part of the cornea, so that the instrument, as it is thrust on, enters the anterior chamber quite at its re-entering angle. Having got the point clear into the chamber, the surgeon thrusts it on for a short distance downwards and inwards, then lowers the knife into a horizontal position, and brings the point out in the sclerotic at a spot opposite to that of its entrance; the edge of the knife, which had been kept upwards, is now to be turned a little forwards, and the corneal section completed. The wound now lies under the still undivided conjunctiva; this is then cut through with the knife, so as to leave a little flap of the membrane loosely covering the wound.

The next step of the operation is to remove the upper part of the iris with forceps and scissors, to such an extent as may seem desirable; then all the anterior capsule is freely lacerated with the cystitome. Next the curette is to be laid upon the lower part of the cornea, and pressed in a direction upwards and backwards, so as to induce the upper edge of the lens to present at the section, and as the lens slowly advances, its egress is to be aided by the curette being steadily carried upwards, with gentle pressure, over the surface of the cornea; and if portions of the soft periphery of the cataract become detached, they are to be helped on in their upward course by repeating the gliding pressure with the curette. To prevent the epithelial surface of the cornea from being abraded during

these movements of pressure, Graefe advises that the curette should be made of vulcanite instead of silver.

EXTRACTION THROUGH THE SCLEROTIC.

I allude to this operation simply because it is mentioned in works on ophthalmic surgery. Those who first suggested it were misled by the apparent advantages of making a wound which would avoid any interference with either the cornea or the iris; but they overlooked the far more serious injury the eye must sustain from a large incision in the sclerotic and choroid, extensive loss of vitreous humour, and the introduction of instruments for seizing and dragging out the lens. The history of the operation is little more than a history of destroyed eyes; and those who wish to satisfy themselves on this point may refer to the cases quoted by Mackenzie in his *Practical Treatise* (4th edition, 1854, p. 812).

OPERATIONS ON OPAQUE CAPSULE.

I have elsewhere alluded to the statements of Stellwag and others respecting the so-called opacities of the capsule (p. 148). Surgically speaking, it matters not whether the capsule, which remains in the pupil after various forms of cataract operations, be in its very substance opaque, or whether it be only coated with opaque material. It obstructs vision, and must be removed.

After the lens has been got rid of by solution, the anterior and posterior portions of the capsule which have been broken through at the centre, retract, and form a white ring, which is often wholly concealed when the iris is in its natural condition, only becoming visible when the pupil has been artificially dilated. Sometimes a band or two may stretch across the pupillary area.

After extraction also, it commonly happens that the shreds of torn capsule form a delicate film, blocking up the pupil; and if any slight degree of iritis has followed the operation, this film may be made additionally dense and visible by exudation of lymph. Even when the area of the pupil looks black and clear, some months after extraction, the surgeon should endeavour to keep the patient in view; for perhaps at the end of a

year or so a filmy membrane will be found stretching across the pupil, so delicate as to be detected only after the closest scrutiny, and with the aid of concentrated light; and yet the existence of this film will just prevent the patient being able to read. Short of this point all objects may be seen well, and yet, for want of tact and care in detecting this slight obstruction to vision, the surgeon may lose the credit and the satisfaction of having performed a first-rate operation.

In some instances, the film, which forms many months after extraction, appears to be produced by an opacity of the hyaloid membrane advancing towards the plane of the pupil after the lens and its capsule have been removed.

There are no manipulations which demand more judgment and care than those for removing capsular obstructions. The two chief points to be observed are: to make the aperture in the capsule central, so that it may correspond to the axis of vision; and to avoid isolating any portions by completely detaching them from the rest of the membrane. Loose shreds, when set floating by unskilful management, are ever afterwards a source of annoyance to the patient. Above all, the division of the capsule is to be made with the least possible disturbance of the vitreous body.

Every movement of the needle should have a definite object. It is useless to make random stabs and plunges at detached portions of capsule, in the hope of depressing them by some lucky hit; for their buoyancy will almost always cause them to return to their former position as soon as the needle is withdrawn. Delicate bands, tightly stretched across the pupil, may be divided in the middle, and then each half will retract towards its fixed point, and leave the interval free.

When a single needle is employed to tear through a portion of capsule, it sometimes happens that the delicate membrane yields and stretches, instead of being torn, and, after each attempt, the surgeon is mortified at seeing it return to its former position. It is in such cases that it is so efficacious to use two needles at once, as suggested by Bowman.* There is hardly any filmy expansion, or hair-like band, that may not by this means be divided.

The lids being held apart with a spring speculum, the surgeon has both hands at liberty, and he separately introduces

* *Medico-Chirurgical Transactions*, 1853, vol. xxxvi. p. 315.

the needles through the cornea, until their points reach the area of the pupil. He then, according to the nature of the obstruction, either makes in the centre of the opaque membrane a small hole, and then enlarges it by drawing the points of the needles in opposite directions, or cuts, twists, or tears through some band or filament which had been holding together the margins of the pupil.

If the rules which I have said should guide the surgeon in effecting the absorption of a cataract be strictly adhered to, namely, to attack the lens at the centre, always working the needle steadily from that point towards the circumference, and to be satisfied with slow progress, without attempting to break up a large mass of lens at the earlier operations; and if he carefully avoids isolating and setting loose any portions of capsule—he will rarely find it necessary to employ any other instruments than needles for obtaining a perfectly clear pupil.

But if a case has already been unskilfully operated on, and the needle used roughly and without any settled aim, it may happen that the entire capsule containing some small remains of white lens-matter has become crumpled up and rolled into an opaque mass, which is either moored in the midst of the pupil by two or three delicate bands, or is attached by a single filament, which allows the mass of capsule to float and sway to and fro with every movement of the eye. In such a case the entire mass of capsule must be extracted.

To effect this, an incision of suitable size is to be made through the cornea near its edge, and a forceps introduced, the points being kept closed until they have reached the capsule. This is then seized, and withdrawn by gentle traction, sufficient to make the retaining filaments give way.

The forceps used for this purpose must be so constructed that, when its points are separated, the iris will not fall between them. The cannula-forceps best fulfils this indication.

Far from having described in the foregoing pages all the operations which have hitherto been devised for the removal of cataract, my narrow limits, and still more a distaste for being a mere chronicler of minute differences of procedure, or abortive attempts at originality, have combined to limit my descriptions to those operations which have been approved of and practised by leading surgical authorities, or which have in some degree secured a reputation by retaining for a considerable period the confidence of the profession. A full account of all the cataract

operations invented up to the present time, with a criticism of their relative value would form a work almost as large as my present essay. I cannot, however, dismiss this most important subject of cataract without a few observations on the relative merits of the operations which are practised for its cure.

For cataract in children and young persons, solution of the lens by keratonyxis, if performed with the careful precautions mentioned at p. 169, appears to me to be a nearly perfect operation. The natural curve of the cornea is preserved; the pupil remains central; in short, all the structures of the globe are left, practically speaking, in their natural conditions, except that the offending lens is gone. The treatment, it is true, extends over several months, although in infants I have seen all the lens absorbed at the end of a few weeks. But even to a young adult, what is the delay of several months, nay, in extreme cases of enforced caution in operating, what is the delay of a year, when good and lasting sight is eventually gained, compared with the patient's loss, when the surgeon, for the sake of a rapid cure, by his over-manipulation or his dangerous activity, calls up destructive inflammation in the eye he was anxious to save?

Sometimes in the course of the most careful treatment by solution, a sudden disruption and displacement of the whole lens occurs; nothing but an immediate incision of the cornea, and removal of the irritating lens-matter, will then save the eye; but this accident seldom happens if proper precautions have been taken from the first.

With regard to extraction, all surgeons, I think, are agreed that, *provided all goes well*, the final result of a good flap operation is superior to that of any other procedure. In an eye where all the tissues are sound except the lens, such an operation skilfully performed, with careful after-treatment until the cure is completed, is a real triumph of surgery, only to be surpassed, perhaps, by the result of an equally perfect operation by solution. But then comes the all-important question, Is all as likely to go well with the ordinary flap extraction as with some of its modifications, or with the scoop operation?

The one great source of trouble after a flap operation is prolapsus iridis. The surgeon may have done his part perfectly, his last look at the eye, before he puts on the bandage, may show him the iris in its proper position, with the pupil central, and the corneal wound in the closest apposition. For three or

four days after the operation, the patient may be quite comfortable, and the eye hardly complained of; and yet when the surgeon makes his first examination, he may find the section gaping, plugged with a mass of iris, the pupil displaced, or even drawn into the wound. Speedy cure or a shapely eye are henceforth unattainable; and the operator must be content if the cornea retains its transparency, and the other tissues are not too far injured by tedious inflammation to allow of sight being ultimately restored by the formation of an artificial pupil.

I know that many surgeons, in discussing the perils incident to flap extraction, would put forward, as one of the greatest sources of danger, the largeness of the corneal wound, as involving loss of vitality in the flap or a slow process of opacity in it. But I do not think that either of these disasters is often caused by the mere length of the incision; and, on the other hand, a free opening in the cornea allows the lens to escape without bruising the edges of the wound, and, what is of still more importance, without leaving behind it any considerable fragments of its cortical portion. Now this latter circumstance is inseparable from every case in which a lens is forced to squeeze itself out through a small aperture. In doing so it must scrape off more or less of its substance, and either these fragments remain, to set up irritation in the iris, or to insinuate themselves into the wound, and interfere with its quick union; or else they are removed by too much surgical interference, too frequent introduction of a scoop, or a suction-curette, or a syringe, or by too much squeezing and pressing of the eyeball. Overmuch manipulation of the eye is, I think, the radical fault both of the modified flap extraction and of the scoop extraction, and, indeed, of most of the attempted improvements of the flap operation.

As for loss of vitreous humour, which, without the slightest fault of the surgeon, sometimes takes place as soon as the corneal flap-wound is completed, it is equally liable to occur during scoop extraction, if the scoop is allowed to pass too deeply backwards, behind the lens, so as to rupture the hyaloid membrane; and an escape is still more probable during the squeezing and pressure which are inseparable from Graefe's modified flap operation.

In giving a preference to the older flap operation, as being, *upon the whole*, preferable to the other forms of extraction, I am

quite aware how much I am influenced by the fact of my having been accustomed to the constant performance of the former operation for a period of nearly twenty years before any modification of it was invented. When I tried the scoop operation in cases which appeared to be especially suitable for it, I found that while the most successful cases left the patient with a deformed and enlarged pupil, and with the optical annoyance of circles of dispersion, inseparable from that condition, I had in less favourable instances to contend with chronic opacity, insidiously invading the cornea, in patients whom I had selected for scoop operation in consequence of feeble reparative powers, which seemed to render dangerous the larger wound of a flap extraction.

In 1834, a celebrated surgeon of that day wrote an essay, '*On the certainty and safety with which the operation for the extraction of a cataract from the human eye may be performed.*' Nine years later another surgeon announced '*An easy mode of dividing the cornea in extraction.*' But in spite of these and other similar assurances—which were by no means borne out by the success of the gentlemen who published them—the really experienced and candid operator will confess that 'extraction made easy' is still an undiscovered boon.

Every modification which has as yet been devised has some especial difficulty or danger. Only those who have had large opportunities of operating, and also of watching the results of the operations of others, can attain to a true estimate of the good and bad points in any given mode of treatment. Published statistical reports only mislead. To class cataract operations as 'successful' and 'unsuccessful' may please the public, but cannot afford real information to the honest and thoughtful practitioner. In general surgery, indeed, many of the most important operations may be thus abruptly divided. In classifying operations for ovarian disease, for instance, we are certain that the growth if left to itself will destroy the patient. If the tumour has been removed, and the patient restored to health, the operation has been successful. If, in consequence of the operation for removal, the patient has died, the operation was unsuccessful. So with the removal of a malignant growth—of a crushed limb—of a stone in the bladder, &c., every one can appreciate the classification of such cases into 'successful' and 'unsuccessful.' But a successful operation for cataract, What is it? The mere removal of the opaque lens from the eye may

be put down by one man as a success. The recovery of a patient with such an amount of sight as enables him to guide himself, is the success of another man. A third is satisfied if his patient can read a few large letters; while a fourth, with a higher standard of excellence, will accept nothing as success short of his patients reading fluently a small type, and seeing distant objects with almost normal distinctness.

Then there is the professor who is so overwhelmed with the work of his clinique, that he must content himself with doing his operations as well as he can, not having the time, even if he had the inclination, to follow up his cases, and ascertain for himself their ultimate result. Of what value can his statistics be?

The 'pious frauds' of charity-committees, who hope, by startling reports of successful cases, to attract fresh subscriptions for the good of their institution, are not to be judged by a scientific standard. Such appeals are addressed to the general public, and are of no interest to the profession.

CHAPTER X.

GLAUCOMA.

'GLAUCOMA' is a term which in process of time has acquired a meaning quite different from that originally conveyed by it. Among the ancients 'glaucoma' signified opacity of the lens, and was therefore regarded by them as a wholly incurable disease, inasmuch as to remove the lens from its position would have been deemed equivalent to displacing the very seat of sight. At a later period the etymology of the word caused it to be applied to many cases of greatly impaired or lost vision attended with fixed dilatation of the pupil; for, in such cases, the change of colour which the lens naturally undergoes in old age, and some slight diminution of its transparency, combined to impart to the light reflected from the fundus of the eye a greyish or drab colour, which, in descriptions, was exaggerated into green; and much labour was expended by ophthalmic writers, not many years ago, in attempts to explain the cause of this so-called green or *glaucomous* tint. In fact, the dull greyish reflex, upon which so much stress was formerly laid, may be

perceived, whenever the pupils are dilated, in the eyes of almost any old person whose lenses are beginning to be cloudy.

The word 'glaucoma' has now come to be used—without any reference to its etymology, and in a purely arbitrary sense—to signify a disease gradually involving the most important tissues of the eyeball, and, if left to itself, ending in total blindness.

It is only since Graefe drew special attention to the subject, that the important *premonitory symptoms* of glaucoma have been estimated at their true value. Long before his time, the more advanced stage of glaucoma, and especially the strongly marked and unmistakeable outward appearances of the disease in its complete form, were perfectly familiar to the profession; but the connection between this hopeless form of blindness and an earlier stage of inflammatory action was not understood; and the merit of explaining this connection, of showing how inevitably changes, apparently of no extreme urgency, lead the way to incurable loss of sight—above all, the invention of operative means for arresting these changes, and restoring the eye to usefulness—all this merit belongs to Graefe.

I will first notice the appearances of glaucoma in its complete stage.

The patients are beyond the middle period of life.

They are usually pale and unhealthy in appearance, often showing that worn expression which becomes impressed on persons who have gone through much suffering.

The eyeball, instead of having the slight degree of elasticity natural to it in health, is remarkably hard, giving to the finger almost the sensation of a stone.

The sclerotic, often marked with faint dusky patches, is traversed by large, purple, tortuous veins, which emerge abruptly, close to the margin of the cornea. Sometimes there is also a slightly-marked vascular zone.

The cornea, although it may be sufficiently transparent to allow of the iris being well seen, presents a peculiar unevenness of its epithelial surface; so that the lines of a window-frame, instead of being distinctly depicted on the corneal surface, appear wavy and irregular: and the reflected light is dull, like that from a slightly steamy glass. In some cases the cornea is hazy throughout its substance, and occasionally the epithelium is found vesicated in small patches.

If the state of the cornea allows a good view of the iris,

these two structures will usually be found in close approximation to each other, the pupil being dilated to its fullest extent; sometimes the pupil is less dilated, but irregular. The change in the appearance of the iris is very characteristic. Its sharply-defined fibrous character is lost, and it assumes a peculiar *slate-colour*. Sometimes the veins of the iris are sufficiently enlarged to be distinctly visible to the naked eye.

The lens advances very near to the cornea, and in cases of old standing is opaque. Sometimes this opacity has a milky appearance, with slight indications of striæ, and the whole lens looks full and swollen, as if it had undergone maceration, and were about to burst its capsule. Occasionally the divisions between the planes of lens-fibres are very distinctly seen. The lens may vary much in colour, appearing greyish or greenish drab, dirty yellow, or dull orange.

Perception of objects is wholly lost; sometimes even, all perception of light.

An eye may present all the above-mentioned appearances in consequence of slow disease, advancing, with intervals of quiescence, during months or even years; or, on the other hand, the same appearances may be the result of an acute inflammatory attack, coming on in the most sudden manner, and within a few days producing all the changes above noticed, with the exception of the opacity of the lens, which takes place more slowly.

Mere inspection of an eye in which glaucoma is complete will not enable the surgeon to decide whether the morbid changes have been the result of the *chronic* or the *acute* form of the disease.

I have already alluded to the merit of Graefe, in having been the first to connect that well-known incurable condition of the eye, to which alone the term glaucoma was formerly applied, with a definite train of premonitory symptoms, marking a period during which surgical treatment might be of service. These peculiar premonitory symptoms consist in intermittent attacks of dimness of sight. A patient perhaps sees well up to the middle of the day, then objects appear as if involved in smoke, and reading becomes difficult or impossible. This dimness may last for the rest of the day, and the next morning it may have quite passed off, to return again in the course of a few hours. This intermittent dimness may go on for months, with little, if any, external appearance of inflammation; in

other cases, the onset of dimness is attended with slight redness and watering of the eyes. In fact, unless the peculiar premonitory symptoms of incipient glaucoma are well understood, a case of the most serious kind may be lightly regarded as one of unimportant catarrhal ophthalmia.

A luminous object, as a candle or a lamp, appears surrounded with a halo of prismatic colours. The iris approaches the cornea, and the pupil is inactive, although perhaps not dilated; and, unless the attack be very slight, the surface of the cornea, instead of presenting a brilliant mirror-like smoothness, will appear slightly dull, like a glass that has been breathed upon; so that the lines of the window-frames will be reflected in a faint and wavy form. This uneven and dull appearance of the corneal epithelium is a very valuable diagnostic mark in all stages of glaucomatous disease, and will often arouse the suspicions of a careful observer in cases which might otherwise be thought unimportant. It is invariably present in all advanced and confirmed cases of glaucoma. The premonitory obscurations may persist for weeks, with occasional interruptions, even for months; and patients may be liable to intermittent attacks for a year or more, before any outburst of acute inflammation occurs. Neuralgia in the ophthalmic division of the fifth nerve, is commonly added to the other premonitory symptoms.

If the eyeball be carefully examined during any period of glaucomatous disease, it will be found in some degree harder than natural. This hardness goes on increasing, until, in the last stage of glaucoma, the globe feels almost like a ball of stone.

I know of no instance in which the *tactus eruditus* of the surgeon is more severely tested, than in examining some of these incipient cases of glaucoma. The same eyeball may suggest to two able examiners different degrees of hardness, or they may even disagree as to whether the eye be abnormally hard at all.

While the patient gently closes the lids, the surgeon is carefully to apply the tips of his fingers upon the upper part of the globe, lightly pressing upon its coats. And again, when the patient opens the lids and looks upwards, the surgeon presses the middle part of the lower tarsus steadily against the sclerotic, just below the cornea, and carefully notes the degree of resistance he meets with. I need hardly say that too great

softness of the globe is as much a mark of disease as too great hardness, and that, to discriminate truly between the various degrees of what is too hard and what is too soft, the surgeon must familiarise himself with the exact amount of firmness and elasticity indicative of a sound state of the coats and humours of the globe, by means of that careful fingering which repeated practice alone can give.

Donders and others have devised formulæ for noting down the amount of tension existing in the globe, but the gradations are so manifold, that it is barely possible to tabulate them correctly according to any fixed plan.

Rest of the eyes, careful attention to general health, and iodide of potassium internally, I have found to constitute the best mode of treatment in this stage; but the patient must be warned as to the true significance of the symptoms, and as to the probable onset eventually of acute glaucoma.

It was to the ophthalmoscopic appearance of the optic nerve and its vessels, in all stages of glaucomatous disease, that Graefe drew such special attention. In well-marked cases the optic nerve appears concave, and the retinal vessels, instead of passing off from their point of emergence in a straight direction, to ramify on the retina, begin by curving over the edge of the cup-like depression at the end of the nerve.* Very slight pressure on the globe with the finger causes visible pulsation in the retinal vessels; or this pulsation may exist without external pressure.

In the slowly-advancing early stage of glaucomatous disease, the depression of the optic nerve may be so trifling as to escape observation; but in confirmed cases it is very marked. When the disease has come to a crisis, and acute glaucoma has set in, the details of the optic nerve and retina cannot be seen with the ophthalmoscope, owing, I believe, in great part to the condition of the corneal surface, which produces irregular refraction of the rays of light. In the advanced stage of glaucoma a dull red glow is sometimes all that can be seen.

As disease goes on, the dimness of sight, instead of being intermittent, becomes permanent, and the field of vision gradually contracts, so that at last the patient in viewing objects

* Plate I. fig. 2. This is a diagram, not a drawing from an individual case. It shows, in a rough way, the abrupt curve of the vessels, the concave form of the optic disk, and the grey tint which the latter sometimes assumes in the very advanced stage of true glaucoma, or of grey atrophy of the optic nerve.

seems to be looking at them through a small hole in a screen. Sometimes, however, this narrowing of the field of vision does not take place, the dimness being pretty uniformly diffused. By this time other marked changes have taken place in the globe. It has acquired a peculiar stony hardness; the veins on the sclerotic emerge abruptly near the edge of the cornea as thick purple trunks; the pupil gradually dilates until in old cases the iris almost disappears, acquiring at the same time a peculiar slaty tint. Eventually the veins of the iris enlarge, and are especially noticeable as a ring-like plexus near the pupillary margin. The lens at last becomes opaque, milky-looking, and indistinctly striated; it is often of a greyish drab, dirty yellow, or dull orange, and marked with earthy streaks and patches. Its threefold division is often very well marked, as if by undergoing maceration in water, it had swollen up and were about to burst its capsule. By this time even perception of light is usually quite lost.

From what I have already stated as to the various changes in glaucoma, it will be understood that it is by a careful comparison and estimate of several morbid appearances taken together, that the disease is to be discriminated, and not by the presence of any one distinctive sign. If mere abnormal hardness of the globe be assumed as the proof of glaucomatous change, several forms of inflammation and degeneration quite distinct from glaucoma may be mistaken for that disease. A 'cupped' condition of the optic nerve may simply be the result of chronic wasting. Coloured halos around luminous objects are commonly associated with ordinary catarrhal ophthalmia. But let all these symptoms co-exist;—intermittent obscurations of vision, prismatic halos, fixity of the pupil, increased hardness of the globe, a changed condition of corneal epithelium, cupping of the optic nerve—and the diagnosis becomes an absolute certainty.

I have said that the course of the glaucomatous process is usually more or less gradual, a longer or shorter premonitory stage preceding the onset of an acute attack; but this sometimes comes on suddenly, frequently in the night, the patient having gone to bed apparently well, and being aroused from sleep by intense neuralgic pain to find himself all but blind. When such an attack occurs, on account of the hazy condition of the corneal epithelium, or some change in the vitreous body, or from both causes combined, the optic nerve and retina cannot

be discerned, and the ophthalmoscope only reveals a dull red glow from the fundus.

Treatment of glaucoma.—While cases of chronic glaucoma which had advanced to their last stage were abandoned as wholly incurable, and beyond all treatment; those of the acute form (under the name of *ophthalmitis interna*, *ophthalmitis arthritica*, &c.) were formerly treated on antiphlogistic principles, pushed to the severest extremes; profuse bleeding, both local and general, and mercury in salivating doses, being the common means employed to check the progress of disease. Some practitioners regarded gout as the primary cause, and, in addition to depletion, employed colchicum, or other anti-arthritis.

In spite of every form of treatment, glaucoma remained the *opprobrium* of ophthalmic medicine; and the announcement, therefore, of its curability by means of an operation at once attracted general attention. In 1857 Graefe* published an account of this operation of 'Iridectomy,' and he also brought the subject before the Ophthalmological Congress which met at Brussels in that year. An incision was to be made through the cornea, close to the sclerotic; a considerable portion of the iris was then to be grasped with a forceps, drawn out, and cut off. By this operation the 'intraocular pressure,' which was the cause of all the phenomena of glaucoma, would at once be removed.

His operation is performed as follows. The globe having been fixed with a forceps, a lance-knife is passed obliquely through the sclerotic, about a line and a half from the spot where it blends with the cornea, so as to make a wound penetrating into the anterior chamber. An iris-forceps is then passed through the wound, a fold of iris seized, drawn out, and then cut off close to its ciliary attachment. Graefe and others lay particular stress upon the iris being removed quite up to this point, but I do not believe it to be at all essential. I have always performed the operation with a Beer's knife, making, in fact, a corneal wound like the upper section for flap extraction, but on a much

* See his essay in the *Archiv für Ophthalmologie* (vol. iii. p. 456), entitled, *On Iridectomy in Glaucoma, and on the Glaucomatous Process*. Also (vol. iv. p. 127, 1858), *Farther Clinical Remarks on Glaucoma, Glaucomatous Diseases, and the Curative Effects of Iridectomy*. These two essays, together with another, *On Coreomorphosis as a Remedy in Iritis and Iridochorioiditis*, were translated, under slightly-changed titles, by Mr. J. Windsor, and published by the New Sydenham Society (vol. v. 1859).

smaller scale. The wound is a good deal anterior to that recommended by Graefe, and passes through the true cornea, but close to its sclerotic union. The iris, consequently, is not divided quite up to its ciliary attachment; and yet I have found the result of the operation just as satisfactory as that first described. In acute glaucoma the lens always advances forwards, close up to the cornea, and is therefore endangered by the thrust made with the lance-knife; whereas, in using Beer's knife, in the way I have mentioned, its point is always kept in front of the iris as it lies against the projecting lens. It appears to me that if a peripheral portion of iris is removed, sufficient to establish a free communication between the anterior and posterior chambers of the aqueous humour, the object of the operation has been attained.*

Hancock has recommended the following operation in glaucoma, as being greatly preferable to iridectomy. The point of a cataract-knife is inserted at the lower and outer part of the edge of the cornea, and carried in a direction obliquely downwards, dividing the sclerotic to about the extent of two lines, and penetrating through the corpus ciliare into the vitreous humour. The incision also divides the attachment of the iris, and the delicate fibres constituting the 'ciliary muscle.' The division of these fibres, which I have already spoken of as chiefly constituting the apparatus for changing the form of the lens in the act of accommodation, is regarded by Hancock as the essential point of the operation, since he believes their spasmodic contraction to be the primary cause of the phenomena of glaucoma.

In performing the operation of iridectomy, great care must be taken to avoid wounding the lens, which, as I have said, always projects towards the cornea, and is sometimes in actual contact with it. This danger is avoided by making the corneal incision in the way I have recommended.

A good deal of blood usually flows from the cut iris into the

* If this view be correct, the explanation which those who prefer Hancock's operation have offered, as accounting for the beneficial effect of iridectomy, becomes inconclusive. They consider that the unintentional division of the fibres of the ciliary muscle, during the performance of Graefe's operation, and not the removal of the piece of iris, constitutes its real value. But if iridectomy, performed in the way I have recommended, be found as effectual as when the iris is removed quite up to its ciliary attachment, it follows that division of the ciliary muscle can in no way contribute to the beneficial result of the operation.

anterior chamber, sometimes quite filling it. This blood soon becomes absorbed, if the eye is kept at rest, and bandaged with a carefully adjusted amount of pressure, for twenty-four hours. When, after this period, the eye is examined, the cornea is found to be clear, and the peculiar unevenness of its epithelial surface has given place to the normal mirror-like smoothness.

The recovery of sight after a well-timed and well-performed iridectomy is most remarkable, in many cases almost amounting to the restoration of former good vision; but in other instances the patient is greatly annoyed by the dazzling appearance and the distortion of luminous bodies, the result of the over large pupil, and the consequent flooding of the eye with light. Tinted glasses, an opaque diaphragm perforated by a narrow transverse slit, either with or without a low convex glass, or other optical contrivances, must be resorted to according to the circumstances of the case. But even if, with all these appliances, the patient is still annoyed by irregular refraction, this comparatively trifling inconvenience is not to be put in comparison with the benefits of iridectomy, without which utter blindness must inevitably have closed the scene.

The precise rationale of iridectomy as a curative means still remains to be accounted for; and it must so remain until we become acquainted with the first origin of glaucoma. We speak, indeed, of the disease as consisting in 'intra-ocular pressure,' but why the fluid contents of the globe are in excess, so as to cause this pressure, is as yet unexplained. We must be satisfied practically to employ iridectomy, without being able to give any clear theoretical reason for our procedure.

SCROFULOUS AND MALIGNANT DEPOSITS WITHIN THE EYEBALL.

As the present treatise on Diseases of the Eye forms part of a general system of surgery, special sections of which describe the pathology of morbid growths, whether malignant or otherwise, I have not thought it necessary to go into the subject of such growths, in connection with the eye, except just so far as they have relation to diagnosis and treatment.

Scrofulous and encephaloid deposits, differing so essentially from each other in their histology, and in the ultimate effects they produce upon the eye, nevertheless present at a certain stage of their progress almost the same external appearances.

It is chiefly in infants and young children that encephaloid

and scrofulous deposits take place, while melanosis is the form more commonly met with in adults.

In scrofulous and encephaloid cases, the first symptom noticed is a yellowish reflection from behind the pupil, having more or less of a metallic brilliancy, like that seen in a cat's eye. The surgeon will find it difficult to form a decided diagnosis at this early stage of the disease. The pupil for a time retains its mobility, and it will therefore be necessary to apply atropine before using the ophthalmoscope; the employment of which, I need hardly say, is often very difficult with timid or restless children.

The retina will be found thrust forwards as an irregularly lobulated mass, and enlarged vessels will be seen ramifying over the uneven surface. As disease advances, the pupil becomes dilated and fixed, so that the ophthalmoscope can be used without any previous application of atropine. The mass slowly advances until it almost touches the hinder surface of the lens, which, up to this period, retains its transparency. Hitherto the patient suffers little pain, there is hardly a trace of increased vascularity about the conjunctiva or sclerotic, and the general health appears little, if at all, affected.

In the second stage, however, both redness and pain set in. The lens becomes cloudy, so that the deposit at the fundus of the eye can no longer be recognised, except by the indistinct yellowish tint which it transmits through the lens. The sclerotic and conjunctiva become deeply injected, and, so soon as the lens begins to press against the cornea, there is a considerable flow of tears, with intolerance of light. The patient becomes restless and feverish, with loss of appetite and irregular action of the bowels. In this second stage, the eyeball becomes enlarged and the cornea opaque. The sclerotic bulges at one spot, as if matter were forming there, or it becomes soft and fluctuating in several places. Usually the softening is most marked just behind the upper margin of the cornea.

Up to this point it will have been difficult, if not impossible, for the most experienced surgeon to pronounce, with absolute certainty, whether the disease under his observation be scrofulous or encephaloid. In either case the sclerotic usually gives way at the most projecting spot, the humours escape, frequently the lens also, and, for a short period, pain ceases, and the patient's general health improves.

If the case be one of *scrofulous* deposit the disease may now

begin to subside, the globe slowly wasting, until, eventually, a mere nodule remains at the bottom of the orbit. Indeed, in some scrofulous cases the globe does not burst at all; but, having become enlarged to a considerable extent, slowly begins to shrink, and at last undergoes atrophy. After destroying one eye, scrofulous disease will sometimes attack the other, with the same result.

But should the deposit be *encephaloid*, a farther change now begins. A soft vascular growth sprouts forth from the opening in the sclerotic, through which the humours of the eye had escaped. This fungous mass enlarges with great rapidity, frequently attaining an enormous size, and exudes a profuse foetid sanies, which, by exposure to the air, dries into brownish crusts, giving to the tumour almost the appearance of a sponge. The separation of one of these crusts, or a very slight touch, often causes bleeding from the vessels which traverse the tumour in every direction. The patient becomes more emaciated and weak, and, after several months of suffering, dies, either from repeated loss of blood, or from the simultaneous development of malignant disease in the brain, or some other important organ.

Melanosis is the form of malignant disease which attacks the eye in adult life. Sometimes the melanoid deposit is so abundant that the whole mass acquires a brownish-black tint; in other instances it is only partially distributed through an encephaloid growth. Although more commonly commencing in an eye not previously diseased, melanosis sometimes attacks one which has already become useless from destructive inflammation.

It is between the choroid and retina that melanotic deposit most frequently takes place; and the visual power of a portion of the retina is often retained to a remarkable degree, while the rest of it has become completely displaced. The same remark holds good also in encephaloid cases. The ophthalmoscope is of course our only means for arriving at an accurate diagnosis of melanotic deposit within the vitreous chamber. When it has burst through the coats of the globe, its dark colour and general appearance would at once proclaim its real nature. Occasionally melanosis appears to originate outside the globe, in connection with the conjunctiva, subsequently involving the sclerotic and other tissues.

The medical *treatment* of encephaloid and melanotic deposits within the globe, as in other parts of the body, can be only palliative. We may lay it down as a rule in the treatment of

such affections, that, while we know of no substance which can cure them, they may often be kept in check for a considerable time by supporting the general powers of the patient; and the more we are able to do this the slower will be the progress of the malignant growth, and the less tendency will it evince to involve the neighbouring tissues. Strict attention to the patient's diet, and to the regulation of his health by means of suitable tonic medicines and pure air, will often retard to a remarkable degree the fatal termination of the disease.

In endeavouring to form an opinion as to the curative results of *surgical operation* in malignant disease of the eyeball, we must altogether dismiss, as untrustworthy, the records of our older surgery. For many of the eyes said to have been removed without any return of disease were doubtless affected with scrofulous deposit, which, as I have said, at a certain stage of its progress, so closely resembles the encephaloid form. Removal of the eyeball should be undertaken only after the most careful examination, both local and general. The surgeon should inquire into the mode in which the various bodily functions are performed, so as to assure himself that no appreciable deposit of a malignant kind has taken place in any of the viscera. He must, as far as possible, ascertain that the encephaloid or melanotic mass is fairly enclosed within the fibrous case of the eye, without having involved the optic nerve, or penetrated through the sclerotic into the cavity of orbit. These conditions cannot be absolutely determined; but attention to certain points will help the surgeon to make some approximation towards a correct diagnosis. If the eyeball be thrust forwards, without its actual volume being increased—if it be habitually turned in any particular direction—if it be fixed, or only movable to a very slight degree—above all, if the point of the little finger passed backwards by the side of the globe, encounters any resisting mass within the orbit, it may fairly be assumed that the morbid deposit extends beyond the cavity of the eyeball; and in such a case its removal would be of doubtful success. Even under the most favourable circumstances the surgeon, when convinced of the existence of a malignant growth, would give a most guarded prognosis; for in no class of operations for the removal of such disease are the statistics more discouraging than in those relating to the eye.

CHAPTER XI.

DISEASES OF THE LACRYMAL APPARATUS.

THE lacrymal apparatus comprises the lacrymal gland, which secretes the tears—the puncta and canaliculi, which convey them into the lacrymal sac, where they temporarily accumulate—and the lacrymo-nasal canal, whereby they are finally conveyed into the lower chamber of the nose.

If we consider the small calibre of the canaliculi we can readily understand that a very slight degree of thickening in the delicate membrane which lines them, or a trifling displacement of the puncta, can suffice to disarrange the mechanism of taking up and carrying on the tears; and accordingly we find that watering of the eye (*epiphora*) is a frequent symptom in various forms of conjunctival inflammation. It also constitutes of itself a troublesome condition, which is constantly being brought under the surgeon's notice.

If the puncta are quite impervious, of course the tears must trickle down the cheek as fast as they are secreted. A contraction or stricture of the puncta or canaliculi will cause a less complete overflow. If the lacrymo-nasal canal be strictured, or its outlet obstructed, the tears passing into the sac will accumulate there, and, together with the pent-up mucus, form a swelling termed *mucocoele*. Unless relief is obtained, the distended sac becomes inflamed, and pus is formed, which eventually discharges itself through an opening in the skin, constituting true *fistula lacrymalis*. This term, however, is often incorrectly applied to abscess of the sac without any perforation of the skin.

When a case comes before us in which there is a continual watery state of the eye, our attention should be at once directed to the puncta. These apertures, in a healthy state, are in contact with the ocular conjunctiva, so that, to bring them into view, it is necessary to draw the margin of the tarsus a little away from the eyeball. If the conjunctiva lining the lower lid has become considerably thickened from chronic inflammation, the edge of the tarsus may be so much everted as to cause the punctum to face upwards, or even directly forwards. In such a position it can no longer take up the tears, which accordingly run over the edge of the lid. In extreme cases of *lippitudo* and

chronic ophthalmia, the puncta, still retaining their natural position, are sometimes found to be so completely obliterated that their position can no longer be detected.

If the puncta are in their natural position, and their openings appear unobstructed, and yet no tears can be made to regurgitate through them when the point of the finger is firmly pressed against the lacrymal sac, just below the tendon of the orbicularis palpebrarum, we may suspect some stricture to exist in the canaliculi. We can ascertain this only by exploring them with a fine probe. This may seem to be a very simple matter; but it requires considerable care and tact, without which much serious mischief may result. The membrane lining the canals is extremely delicate, and any want of gentleness in passing the probe may tear the membrane, and so give rise to fresh obstruction. We must bear in mind the abrupt turn which the canal makes at a short distance from the punctum. In passing a probe into the lower canaliculus, the instrument should be directed almost vertically downwards for about half a line, and then turned inwards towards the nose, in which direction it will pass on, should no stricture exist, until its point strikes against the inner wall of the sac, where it lies against the bone. During the whole process of introducing the probe, the tarsi should be kept on the stretch, by drawing outwards the external canthus.

Except to a practised hand, it is often difficult to detect whether the point of the probe is arrested close to the junction of the canaliculus with the external wall of the sac, or whether the point has reached the internal wall. In the former case any onward pressure with the instrument produces a slight dragging of the tarsus; whereas contact of the probe with the inner wall of the sac not only conveys to the hand a peculiar feeling of firm resistance, but at once causes all movement of the tarsus to cease.

If the canaliculi be found free from stricture, and the sac forms a distinct prominence below the inner canthus, it is pretty certain there is an obstruction at the lacrymo-nasal canal. If this canal be perfectly closed, while the canaliculi are free, firm pressure of the finger on the swollen sac will cause its contents to escape at the puncta; but if the canal, although narrowed, be pervious, steady pressure in a direction downwards and a little backwards, may overcome the resistance of the stricture; the swelling then suddenly yields, and the contents of the sac pass into the nose.

When we consider that the membrane lining the outlet of the lacrymo-nasal canal is that common to the chambers of the nose, we cannot be surprised that catarrhal inflammation of this membrane should be a frequent cause of lacrymal obstruction. If pressure on the sac suffices to empty its contents into the nostril, the inconvenience of the partial obstruction at the outlet may be kept in check by the patient taking care frequently to make this pressure, and to use at the same time other means for restoring the lining membrane of the sac as well as that of the nose to a more healthy condition. But if this pressure is omitted, and the tears and mucus are allowed to collect and to distend the sac, this distension, under some attack of catarrhal inflammation, may suddenly transform the chronic disease into an acute one. Pain is then felt in the part; the lids become red and puffy,—sometimes assuming an erysipelatous appearance; and the patient is quite unable to separate the tarsi. The swollen sac feels hard to the touch, and even slight pressure on it is extremely painful, while it fails to press out any thing from the puncta.

These symptoms show that suppuration is taking place within the sac. If the case is left to itself, the pus escapes by bursting through the skin, and the opening frequently remains fistulous, allowing the tears, which have passed through the puncta into the sac, to trickle out upon the cheek, thus constituting a true *fistula lacrymalis*. After all inflammation has passed away, and the redness and swelling which attended the formation of the abscess have disappeared, the fistula often contracts to such a small aperture, that, were it not for the tears which slowly distil from it, the opening would hardly be perceptible. It is about the size of a pin-hole, and almost resembles one of the puncta in minuteness of aperture.

Treatment of lacrymal obstructions.—These obstructions, varying as they do from a slight thickening of some portion of the lining membrane of the sac or nasal canal, causing occasional watering of the eye, up to a total occlusion of the nasal canal, with displacement or stricture of the puncta and canaliculi, cannot of course all require the same kind of treatment. Slight cases of thickening of the lining membrane of the sac, if of recent date, may be much benefited by the repeated application of small oval blisters, about half an inch long, over the sac. Astringent solutions of alum or tannin may, at the same time, be dropped into the corner of the eye, so that they may follow the course of

the tears, and thus reach the thickened membrane. This object may be facilitated by slitting up the canaliculus in the manner hereafter to be described. Each time the drops are used, the sac should be previously emptied, by pressing the point of the finger upon it in a downward direction. Should the lining membrane of the nose be in a thickened state, injections of astringent lotions into the nostril are of service; and in all cases attention to the general health and suitable tonic medicines are indicated.

Warm water-dressing should be applied whenever acute inflammation of the sac sets in with the symptoms I have described. This form of applying warmth and moisture is, in all affections of the lids and parts about the eye, to be preferred to poultices, as the latter frequently produce a troublesome form of eczematous eruption. Diligent application of water-dressing for four-and-twenty hours will frequently subdue acute inflammation of the sac to such an extent that not only do the redness and swelling of the lids disappear, but the thickening of the internal membrane gives way; so that gentle pressure over the sac suffices to empty its contents into the nose, and the case returns to its chronic condition. Should this not be the case, an incision must be made into the sac, and exit given to the pus.

There is hardly any form of local disease which has given rise to a greater variety of surgical treatment than chronic distension of the lacrymal sac, and stricture of its nasal duct. The distended sac has been compressed by an apparatus of pads, adjusted by means of springs and screws. The strictured sac or duct has been subjected to gradual dilatation by means of strings of catgut, introduced through an opening made into the sac, and brought out into the nostril; strings of increasing thickness being used as the canal would admit of their passage. Dilatation of the stricture was at one time attempted from below, by means of curved sounds, introduced into the sac from the nostril; but these instruments were difficult to introduce, there was great risk of breaking with them some of the fragile bones in the neighbourhood of the nasal duct, and they could not reach a stricture situated high up towards the entrance of the canaliculi. At one time metal tubes were placed in the cavity of the sac, which were intended to be healed in, and permanently to occupy its cavity; but Nature, disliking foreign bodies, even when introduced by a surgeon, always rebelled against them, and did

her best to dislodge them, either upwards or downwards. The *style* maintained its ground longest, and until recently formed the *ultima ratio* in every case of obstinate lacrymal obstruction. It was made long enough to reach from just below the tendon of the orbicularis palpebrarum, where an incision was made into the cavity of the sac to admit it, to near the floor of the nostril. The upper end was furnished with a nail-like head, to support the style in its proper position; and it was intended that the tears, entering by the puncta and canaliculi, should come into contact with the piece of metal, and glide down by the side of it into the nose. The style was to be taken out every day, cleansed and replaced; and at first the cure appeared perfect; but patients, from timidity, awkwardness, or carelessness, neglected this precaution, the instrument was seldom, in some cases never, removed, and eventually it became encrusted with earthy deposit from the tears, or was consumed by oxydation; the skin around the nail-shaped head was drawn in, and at the same time blackened with the sulphuret of silver,—in short, the style, so highly praised at first, became at last a source of annoyance and disappointment.

About eighteen years ago, Bowman* suggested a very simple and useful operation, which, in many instances, suffices to cure *epiphora* resulting from contraction or displacement of the puncta, while at the same time it affords a ready access to any obstruction that may exist in the course of the sac or lacrymo-nasal canal.

Suppose that, in consequence of chronic ophthalmia, or from any other cause, the lower punctum has become displaced, so that, instead of facing towards the eyeball, it is directed upwards and forwards; the tears in such a case will run over the edge of the lid; and the object of the surgeon must be to transfer, as it were, the displaced punctum to a position where it can catch the tears before they overflow the border of the tarsus. The lid being put upon the stretch, a fine grooved director, or, in default of that, an ordinary punctum-probe, is to be passed along the whole course of the canaliculus, and held firmly there, while a fine sharp-pointed knife is run along the probe, as far as the caruncle, so as completely to lay open the canal, and thus extend its orifice backwards to the point where the tears accumulate. A very handy little knife, with a slightly

bulbous point, has been invented, with which the canaliculus can be slit up without the use of any probe or director.

For several days after the incision has been made through the upper wall of the canaliculus a probe must be passed along its track, to prevent the lips of the wound growing together. In some persons it may be necessary to use the probe for ten days or more; in other cases there is hardly any disposition in the edges of the wound to unite.

When the overflow of tears depends simply on faulty position of the punctum, this laying open of the canaliculus may of itself effect a cure. In cases of obstruction in the lacrymal sac or its nasal duct, the incision affords an easy access to the seat of stricture.

Occasionally, however, another complication exists in a narrowing of the canaliculus just at its point of communication with the sac, which may prevent the passage of a probe sufficiently large to act upon the stricture. In such a case a small straight cannula, containing a lancet-shaped point, which may be protruded or withdrawn by means of a spring,—in fact, Stafford's instrument for dividing urethral stricture, made on a miniature scale,—must be carried along the canaliculus, and employed upon the constricted spot.

The probes for dilating strictures in the sac or its canal must be of various degrees of thickness, but all sufficiently strong to sustain the requisite amount of pressure without bending. They are best introduced by the surgeon standing behind the patient; and it will be found advisable to avoid using those of too small a size, as they are of course more likely than those of a larger size to catch in a fold of membrane, or even to pierce the membrane covering the bony walls of the canal.

The tarsus being put on the stretch, the probe is passed along the newly-opened canaliculus until its extremity strikes against the inner wall of the sac. Still keeping its extremity in contact with this part, the probe is raised to a vertical position, and then carefully carried downwards to the seat of stricture. The canal inclines somewhat backwards, and this inclination is to be carefully borne in mind. The surgeon must feel his way with the point of the instrument, and be on his guard against using unnecessary force. In cases of old dilatation of the sac, its relaxed lining membrane readily catches in a fold against the point of the probe, and the surgeon must learn to discriminate between a check arising from this cause, and the obstacle

encountered by the instrument becoming impacted in the constricted lacrymo-nasal canal. The length of the instrument which has been passed in, and the patient's own feelings, will prove whether the point of the probe has entered the nasal cavity.

It sometimes happens that, immediately after the first passage of the probe, the surgeon is able, by pressure over the sac, to force all its contents down into the nose; but if there has been much difficulty in passing the instrument, the membrane becomes swollen, and will allow the contents of the sac to pass only after the swelling has been relieved by fomentation.

No fixed rules can be laid down as to the frequency with which the probe is to be used, nor as to the length of time required for a cure. This will vary from a few weeks to several months, and relapses frequently occur long after the stricture appears to have been completely overcome. Too frequent use of the probe will set up irritation, and induce a more abundant muco-purulent secretion. When this takes place, the probe must be laid aside for a week or two, and fomentation, with water-dressing at night, be substituted.

During the whole course of treatment by means of the probes, the patient must never neglect several times a day to press out the contents of the sac, endeavouring to do this in a downward direction; or, if this cannot be effected, by pressure through the puncta.

Those who are about to treat a case of long-standing lacrymal obstruction by the passage of probes, should clearly understand how much care, tact, and patience such an undertaking requires. In consequence of the minuteness and delicacy of the parts concerned, the treatment of a stricture in the lacrymo-nasal duct demands even greater care and skill than that of a stricture in the urethra; and I am sure that those who have seen much practice will bear me out in asserting, that by far the greater part of obstinate and dangerous cases of the latter kind are due to meddlesome surgery rather than to any original disease.

The surgeon must bear in mind that the walls of the lacrymal sac and duct are composed of extremely brittle and fragile bones, and the rough introduction of a probe may either break some of these, or tear away the delicate and vascular membrane which covers them. Besides, as the lacrymo-nasal canal is a bony tube, all thickening of its lining membrane must take place concentrically; and therefore any undue violence, by setting up

inflammation, is sure to increase instead of lessening the cause of stricture.

Even when all possible care and skill have been employed, the treatment of stricture in the lacrymal passages, by the means just described, is often extremely tedious ; for the affection may be complicated with great dilatation of the sac, caries of the adjacent bones, or false passages of various kinds, resulting from previous mismanagement.

Dacryolithes.—This term has been applied to certain concretions which are sometimes met with in the lacrymal passages, in the canaliculi, or in the sac, caused by the earthy salts contained in the tears becoming deposited in the form of a calculus. Watering of the eye, repeated attacks of inflammation in the sac, or swelling and suppuration about the canaliculus, and pain when the part is pressed upon, are the more obvious symptoms. A probe carefully passed into the canaliculus, or through it into the sac, would detect the presence of the concretion, which must be cut upon, and extracted with a scoop or other instrument.

Irritation of the lacrymal passages is sometimes caused by the intrusion of a detached eyelash into one of the canaliculi. In this curious accident the hair enters at the punctum, and passes on as far as the abrupt bend which the canal makes at about a line's distance from the orifice. Here it is arrested ; its point protruding to a greater or less extent, and irritating the caruncle and semilunar fold. The symptoms induced are a pricking and itching about the inner canthus, with reddening of the neighbouring conjunctiva. If the hair be short, its point will protrude so little as to make it very difficult of detection ; on its withdrawal, all irritation at once ceases.

DISEASES OF THE LACRYMAL GLAND AND ITS DUCTS.

The works of foreign writers present a formidable array of diseases affecting this gland, almost every form of acute and chronic inflammation, and enlargements, both simple and malignant, being recorded ; while our own countrymen appear to have met with but few cases of the kind. My own experience would lead me to believe that compared with the other glandular structures of the body, the lacrymal gland is very rarely the seat of

disease. Its sheltered position beneath the projection of the frontal bone guards it, to a great extent, from external violence, and it appears but seldom to participate in the inflammation of neighbouring tissues.

One rare affection consists in an accumulation of tears in one or more of the obstructed excretory ducts, whereby a cyst-like tumour is formed in the upper lid (*dacryops*), becoming very visible when the lid is everted. If one of these enlargements is punctured, without attention being paid to the after-treatment of the case, the opening is apt to become fistulous (*dacryops fistulosus*), the lacrymal secretion continuing to distil through a minute aperture in the skin. Such a case may be treated on the same principle as a fistula of the parotid gland, namely, by passing in at the opening a thread, which, having been carried through the thickness of the lid, and brought out at its conjunctival surface, has a small knot made at one end. This knot is then drawn into the fistula, and, by continued traction of the other end, is made to ulcerate its way through the conjunctival surface. The tears being thus diverted, the fistulous orifice in the skin may be closed by paring and uniting its edges.*

Should the lacrymal gland really become the seat of malignant deposit, or should it be deemed advisable to extirpate it on account of chronic enlargement, or for any other cause, the operation would be a simple one, and would offer nothing worthy of remark.

In the only instances, three in number, where I have myself extirpated the gland, it was not the seat of disease, but was removed to do away with the inconvenience of the overflow of tears, the puncta and canaliculi having been wholly destroyed by extensive burns. In one of these cases an artificial pupil I had made would have been rendered almost useless, in consequence of the flooding of the eye with tears, had their secretion been allowed to continue.†

* See a well-reported case of *dacryops*, by Hulke, *Ophthalmic Hospital Reports*, vol. i. p. 287, 1859. In this instance a loop of thread was made to include a certain portion of the conjunctiva.

† See *Guide to the Practical Study of Diseases of the Eye*, 2nd edition, 1859, p. 417.

CHAPTER XII.

DISEASES OF THE EYELIDS.

So many various tissues enter into the formation of the eyelids that they must necessarily be liable to a great variety of diseases; but it would be absurd to attempt a description of all the morbid conditions which they share with the other portions of the common integument of the body.

The *orbicularis palpebrarum* is subject to a spasmodic twitching of some of its fibres, usually those of the lower lid, producing a visible quivering of the skin, popularly termed the 'live-blood.' To persons of an irritable nervous system this becomes teasing from its frequent recurrence. It is commonly the result of intestinal irritation, especially that produced by ascarides; and a few doses of purgative medicine, followed up by tonics, usually suffice to put an end to the annoyance.

Epicanthus is a term applied to a slight deformity, sometimes observed in children, consisting in a crescentic fold of redundant skin at the inner corner of each eye, partly or wholly concealing the caruncle. It is associated with a depressed form of the nasal bones, and if, in after life, the bridge of the nose becomes more prominent, the fold of skin, to a certain extent, diminishes, although it never wholly disappears. *Epicanthus* imparts to the face an unpleasant, Chinese expression; and the only cure is by pinching up and removing a vertical fold of skin on the median plane, just between the eyebrows, and then bringing the wound accurately together.

Ptosis, or drooping of the upper lid, may exist in various degrees, producing merely a slight deformity, or becoming complete, so as wholly to obstruct vision. It will be spoken of under 'paralysis of the third nerve.' In some cases of congenital drooping of the lids it is possible that the levator palpebræ muscle may be altogether wanting. Patients with this defect have no power of moving the lids except by calling into action the occipito-frontalis muscle. The lids do not present that transverse fold in the skin, which, in the normal state, corresponds to the upper part of the eyeball, but are smooth and un wrinkled from the eyebrow to the tarsus, while the forehead is furrowed by the frequent action of the occipito-frontalis.

The terms *Entropion* and *Ectropion* are respectively applied to the inversion and eversion of the margins of the lids.

The simplest form of *entropion* is that which is occasionally met with in children, the subjects of irritable ophthalmia, as a result of spasm of the orbicularis palpebrarum. Extreme intolerance of light induces this muscle to contract so often and so forcibly that at last the lower tarsus rolls over against the globe, causing an inversion of the eyelashes, which greatly adds to the patient's distress. Contractile collodion, painted on the skin of the lower lid, draws the part into a proper position, and keeps it so while suitable remedies are being employed to subdue the original disease.

A similar spasmodic inversion of the lower lid happens to old persons, in whom the skin is relaxed and the tarsus flaccid. The muscular contraction is repeated until at last the lid becomes so rolled upon itself, that both the cilia and the tarsus are completely hidden, and the border of the lid appears to be formed of common integument. In these cases of extreme inversion the irritation is really much less than when the inversion exists to a slight degree. For in the latter case the points of the cilia are brought into direct contact with the ocular conjunctiva, while in the former case the tarsus rolls over so completely, that the points of the cilia become buried in the fold of palpebral conjunctiva, and consequently do not come into contact with the globe at all.

A far more severe and obstinate kind of entropion is that which follows chronic inflammation of the palpebral conjunctiva, especially neglected or maltreated purulent ophthalmia. The upper tarsal cartilage becomes so much curved upon itself, that the whole range of eyelashes turns backwards against the globe. This curving of the tarsus is often aggravated by the long-continued application of solid nitrate of silver and sulphate of copper to a granular conjunctiva. If in such cases we evert the lid, we find a pale smooth cicatrix occupying its deep concavity. Partial or complete inversion of the margin of the lids may also result from contraction of the conjunctiva, following injury from acids, caustic alkalies, or burns.

A great variety of operations has been devised for the cure of entropion. In that form, so common in old persons, where the inversion is owing to contraction of the orbicularis muscle acting upon a flaccid lid, a cure can usually be effected by removing an elliptical portion of the skin of the lid, together with the subjacent fasciculus of muscle, and then accurately

uniting the wound with fine sutures. It requires care exactly to calculate what quantity of skin should be taken away; and of course the removal of too large a portion would cause eversion of the lid, and so produce a deformity of the opposite kind.

If the tarsal cartilage be so much curved that removal of skin is insufficient to draw the eyelashes away from the globe, recourse may be had to an expedient suggested by Streatfeild. The skin of the lid being carefully dissected up, sufficiently to expose the convex surface of the tarsal cartilage, a long narrow wedge-shaped slice is cut out from this, so as to form a groove extending the whole length of the tarsus. The curved cartilage thus becomes bent backwards, as it were, and the skin being restored to its position, is united along the cut edges with a few fine sutures.

Should all these plans fail, and the eyelashes still irritate the globe, the whole row must be dissected off, together with that portion of the tarsal margin in which their roots are imbedded.

Ectropion, or eversion of the lids, may exist in the most various degrees. Its worst form is seen as a result of burns of the face, followed by extensive contraction of the cicatrices.

A spasmodic form of *ectropion* is often seen in purulent ophthalmia of infants, and in scrofulous and irritable ophthalmia of older children. In infants the unsightly appearance of the bright red and swollen conjunctiva gives rise to great alarm in those who have the care of the child; but they may be assured that as the inflammation subsides, the deformity will gradually cease.

The chronic forms of *ectropion* in adults, which are produced by granular thickening of the conjunctiva after purulent ophthalmia, or by the contraction of cicatrices in the skin surrounding the palpebral aperture, the result of ulcers, burns, exfoliation of bone, &c., require a variety of operations, according to the special nature of the case.

When, after chronic ophthalmia, the everted conjunctiva of the lower lid presents a thick mass of granular excrescences, without any material elongation of the tarsus, or disease of the neighbouring skin, a cure may sometimes be effected by removing with scissors the greater portion of the palpebral conjunctiva, and then uniting the edges of the wound with very fine sutures. These may be left to ulcerate out by themselves, the lid being kept in proper position by the aid of a pad

of lint laid along the margin of the tarsus, and fixed by means of several layers of lint saturated with collodion. In this way the lids are kept in contact with each other, and the apparatus need not be disturbed for several days. When the wound in the palpebral conjunctiva is closed, the loose stitches may be removed, and the pad of lint replaced until the cure is complete.

In very old and severe cases of ectropion, the tarsus becomes so much stretched, that, in addition to the removal of conjunctiva, it is necessary to take away a wedge-shaped portion of the elongated lid itself. Still worse cases, such as those resulting from burns or disease of bone, may require the formation of a new eyelid by the transplantation of a portion of adjacent healthy skin.

Trichiasis consists in an irregular growth of the eyelashes, the general form of the tarsus itself not being changed. *Tinea ciliaris* very commonly causes trichiasis, by inducing cicatrisation about the roots of the cilia. Sometimes three or four fine eyelashes present their points towards the globe, or even a single hair will grow in this direction, all the other hairs maintaining their natural position.

Trichiasis, when existing only to a slight extent, causes constant annoyance to the patient, by a sense of pricking, and by the constantly irritable and watery state of the eye which it induces. If only a few hairs grow irregularly, the removal of the entire tarsal margin need not be resorted to. The offending hairs must be carefully plucked out from time to time; or if they form a little group, they may be removed by dissecting out the small portion of lid external to the tarsus itself, in which their roots are implanted, and then uniting the wound with a suture.

To draw out an eyelash by the root seems a very simple and trifling matter; and yet there are few surgical manipulations in which care and the skilful use of a well-made instrument are so necessary. The cilia-forceps one commonly meets with are liable to cut the hair instead of merely grasping it firmly; and the stiff broken stump of a hair causes far more distress to the patient than its natural fine point. The hair should never be sharply jerked out, but removed with a slow steady pull.

INFLAMMATION OF THE LIDS.

The eyelids are of course liable to the various forms of inflammation which attack similar tissues in other parts of the body.

A few inflammatory affections of the lids seem to demand notice on account of their presenting peculiarities of appearance, or being distinguished by special names.

A *stye* (*hordeolum*) is in fact a minute boil. It begins at the very edge of the lid, as a small, red, tense swelling, and at first is merely troublesome by the itching and sense of stiffness it occasions. As the inflammation goes on, the redness and swelling may more or less involve the whole lid, so that the eye becomes completely closed. In a few days matter forms, and shows itself at the summit of the stye; the cuticle gives way, pus and a small slough of areolar tissue escape; and then the redness and swelling subside, and the lid soon assumes its former appearance.

Scrofulous and delicate children are the usual subjects of styes, and they are comparatively rare in adults. Attention to the state of the bowels, carefully regulated diet, and the use of tonics, comprise the general treatment. Locally, warm water-dressings are greatly to be preferred to poultices, which are apt to irritate the skin. The stye should never be rubbed or squeezed; and no incision is necessary, except perhaps, a slight puncture through the cuticle when the pus is pointing.

Abscess sometimes occurs in the Meibomian follicles. These organs pour out upon the edges of the lids a greasy secretion, which prevents the tears running over, and causes them to flow onwards to the puncta. Sometimes a follicle becomes obstructed at the orifice, and the retained secretion forms a minute solid granule, looking, when extracted, like a little grain of sand. If it projects sufficiently to touch the globe, a slight irritation is produced until the granule is removed.

If, however, the solidified secretion cannot in this way escape through the orifice of the follicle, it causes irritation, and at last a small abscess in the follicle itself. The lower lid is commonly the seat of these abscesses. They commence with a small patch of vascularity in the palpebral conjunctiva, a short distance from the free border of the tarsus, and gradually a yellow dot of pus forms in the centre of the vascular patch. If the conjunctiva at this point be punctured with a lancet, and a small scoop be introduced, the cause of the suppuration, a little nodule of stearine, about the size of a poppy-seed, may usually be turned out, and then all irritation subsides.

Tinea ciliaris,—termed also *ophthalmia tarsi*, *psorophthalmia*, *tinea palpebrarum*, &c.,—is one of the most common and troublesome diseases of the lids. It is too often neglected during the early stage, when alone it is really curable, and the surgeon is probably consulted for the first time when many of the hair-bulbs have already been irreparably destroyed, and the remaining hairs are misplaced and inverted, constituting the state called *trichiasis*. This term is frequently employed as if synonymous with entropion, but it ought properly to be restricted to mean displacement of the *hairs* themselves, while entropion signifies a turning-in of the *lid*.

Tinea ciliaris is seldom seen in its early pustular form; for the little pustules at the roots of the eyelashes soon break, and the discharge exuded from them dries into crusts, which cling about the hairs, matting them together, and sometimes almost concealing them from view. *Tinea ciliaris*, if allowed to go on unchecked, gradually destroys the tissues which secrete the hairs; and when the disease has thus exhausted itself, and the last crusts have fallen off, the tarsi, instead of presenting sharply-beveled edges, appear rounded off, the skin and conjunctiva being gradually blended together into one smooth, red, shining cicatrix, in which neither cilia nor Meibomian orifices can be traced. Very often the puncta also become obliterated, and the tears consequently run over the cheeks, causing irritability and blinking of the lids. This is the condition to which the term *lippitudo* should be restricted; *tinea ciliaris* being understood to mean that state in which active disease at the root of the eyelashes is still going on.

In the *treatment* of *tinea ciliaris*, the chief difficulty arises from the age of the patients. Daily attention is required, to prevent the accumulation of crusts, which should be carefully washed off night and morning. Patients often derive but little benefit from the remedies prescribed, in consequence of this regular cleansing being neglected. It is useless to apply ointments any where except upon the very surface of the minute sores at the roots of the hairs; and if the latter are kept closely cut with scissors, the application of ointments, and the prevention of crusts, are greatly facilitated. Of course, this cutting of the eyelashes requires to be done by the surgeon himself, and the ointment should be neatly applied with a pencil. When cases cannot be thoroughly looked after, it is perhaps better to prescribe lotions, as they can hardly fail to reach the seat of

disease. Ung. hydr. nitratis, ung. hydr. nitrico-oxydi, and ung. zinci oxydi, sufficiently diluted with ung. cetacei, or fresh lard, are the best ointments. The acetate of lead may be used as a lotion, in the proportion of from two to four grains in the ounce of distilled water.

The worst forms of lippitudo may often be greatly relieved by slitting up the canaliculi in the manner described at page 227. By this means the overflow of tears is checked, and this of itself is an immense comfort to the patient; while, at the same time the tendency to ectropion, which long-continued lippitudo often induces, is considerably diminished.

Phtheiriasis.—Among the irritable conditions of the eyelids, I may here notice that arising from the presence of lice. These creatures are ‘crab-lice’ (*phthirius*), a species quite distinct from that which infests the scalp (*pediculus*). They thrust their heads into the skin at the roots of the cilia, and by means of the sharp claws with which all their legs, except the first pair, are provided, hold on so firmly, that they cannot be dislodged without great difficulty.

Phtheiriasis of the eyelids is an extremely rare affection, at least in this country, and I have met with only three or four instances, all of which occurred in children. On superficial examination, the cases are very similar to those of *tinea ciliaris*. The eyelashes present a powdery appearance, and their roots seem to be clogged with yellowish-gray and brown crusts; but by careful scrutiny of these supposed crusts, the movements of the insects may be detected; and the powdery appearance of the cilia is owing to their being clogged with the exuviae of the creatures, and dried sanies from the wounds they have inflicted. The insects may speedily be destroyed by thoroughly smearing into the roots of the eyelashes the white precipitate ointment (ung. hydrarg. ammonio-chloridi).

MORBID GROWTHS OF THE LIDS.

The following are the more common swellings which appear in or upon the lids.

Cysts, of two distinct kinds. Those of the first kind, extremely common, are met with both in the upper and the lower lid (*Encysted tarsal tumour*, Tyrrell; *Chalazion*, Mackenzie); the others are found almost invariably at one spot, namely, just over the

external angular process of the frontal bone, to the periosteum of which they are attached.

Molluscum is met with on the lids of children, and seems identical with the little masses termed by Tyrrell 'glandiform,' and by Mackenzie 'albuminous' tumours.

Warts are sometimes found on the lids, differing in no respect from those on other parts of the body.

Nævi materni, resembling those of other parts.

1. *Cysts* of the lids are met with at all ages. They may exist singly, or several may appear together, coming successively to their full growth. The skin over them is quite unchanged, so that, when small, they are hardly recognisable except by the touch. They feel like half a hemp-seed or half a pea fixed by the flat side to the tarsal cartilage, and presenting a convexity towards the skin, which may be freely moved over them. They rarely exceed the size of a pea, except when suppuration has taken place within them.

If the lid be everted, the position of the cyst is recognised by a thinning of the tarsal cartilage, forming a dusky spot, around which the conjunctiva is reddened. These cysts may remain of a moderate size during life, without causing any inconvenience; but sometimes they suddenly inflame and become enlarged, the skin over them reddens and at last gives way, a small quantity of pus escapes, and afterwards a thin sanies continues to ooze from the aperture. But more commonly the pus makes its way through the palpebral conjunctiva, and then a little red fungous mass gradually protrudes, which, by the continual pressure of the eyeball, becomes flattened out into a mushroom shape.

When these cysts are so small as to escape ordinary observation, they require no treatment; but if they become so large as to be unsightly, and, still more, if they inflame and suppurate, they must be treated in the following way. The lid being everted, a crucial wound is made through the conjunctiva into the cavity of the cyst. If the inflammation has been acute, pus escapes, otherwise a little serum. A scooped probe passed into the cavity, and twirled about in various directions, brings out the accumulated epithelium, which has a jelly-like appearance. Blood then fills the cyst, and makes it as large as it was before the incision. The patient, however, may be assured that this swelling will gradually subside. To prevent premature closing of the wound, and refilling of the cyst, the probe should be used in the way just described every third day for about a

fortnight. The walls of the cyst come together, and ultimately form a slight thickening in the lid, just perceptible by the finger applied to the skin.

Fibrous cysts, varying in size from that of a large pea to that of a hazel nut, and containing sebaceous matter and hairs, are almost invariably confined to one situation, namely, just over the external angular process of the frontal bone. They appear to be congenital; at least, I have seen them of considerable size in infants four or five months old. The skin over the cyst retains its natural appearance, and it is only on account of the unsightliness that the surgeon is consulted.

In dissecting out the cyst, which is the only mode of treatment, great care is requisite to avoid cutting into it: and especially while the cyst is being separated from the periosteum to which it always adheres pretty closely. The cavity is lined by a smooth membrane, and is filled with white greasy material interspersed with loose hairs. In a cyst removed by one of my colleagues from an infant five months old, these hairs were still growing from the lining membrane. It seems that, in the course of years, these hairs may attain a considerable size, while the fatty material degenerates into oil. Such was the case in a very large cyst which I removed from a woman between thirty and forty. The skin had become so much thinned as to have assumed a dusky hue; and in endeavouring to dissect out the cyst I punctured it, and there escaped a quantity of perfectly clear yellow oil. There remained within the cavity only some detached black hairs, loosely curled together, and as strong as those of the head.

2. The little masses described by Tyrrell as 'glandiform tumours' appear to be identical with *molluscum*, which attacks children in the form of small, white, rounded bodies, scattered over the lids, the *alæ nasi*, and about the corners of the mouth. When very small, these bodies are slightly reddish; but when as large as a pea, they are white, and exhibit at the apex a minute opening through which a milky fluid exudes on pressure. The readiest way to get rid of these unsightly masses is to split them all through with a lancet, and then to nip out with the nails the contents of each. The mass, when pressed out, looks almost like a fragment of parotid gland.

3. *Warts* may be snipped off with scissors, the little wound

being touched with nitrate of silver ; or they may be tied at the base with a fine silk, and allowed to slough.

4. *Nævi* of the lids differ in no respect from those met with in other parts of the body ; but they require more careful and discriminating treatment, on account of the importance of avoiding as much as possible, any considerable loss of skin ; a large cicatrix being not only in itself unsightly, but likely, by its contraction, to cause distortion of the lid. Subcutaneous ligature, therefore, or the introduction of probes coated with fused nitrate of silver, must be preferred to including any portions of skin within a ligature, or extensively destroying it with escharotics.

I have seen injections of alum cause sloughing of the lids and great subsequent deformity ; and such a result might follow the injection of any similar fluid into the loose areolar tissue of the part, unless some contrivance can be used to restrain the fluid within proper limits.

In the following case an injection of tannin proved successful.

A young lady was brought to me with a *nævus* on the upper lid, the size of a small hazel-nut. I was informed it had already been twice operated on by the introduction of threads steeped in nitric acid, and much inflammation and sloughing had ensued, as was proved by a considerable cicatrix of the skin near the outer canthus. The apex of the swelling was on the free margin of the lid, on everting which, a small bunch of veins, about the size of a barley-corn, was seen projecting through the tarsal cartilage, only covered by conjunctiva. The *nævus* seemed to be formed almost wholly by veins, the larger trunks of which could be felt through the skin, as they emerged below the superciliary ridge.

Having enclosed the whole upper lid in a 'ring forceps,' I could completely isolate the *nævus* from its parent veins, and I then punctured it with a very small narrow knife (Hays's needle-knife), and cut up its tissue subcutaneously. Being emptied of its blood, the *nævus* collapsed ; and I next, with a fine syringe, threw in a few drops of a saturated solution of tannic acid. After a short pause, I relaxed the pressure of the ring forceps, and so allowed the returning blood to mingle with the injected fluid.

The subsequent inflammation produced a good deal of swelling and hardness of the lid ; but the only slough was a mass about the size of a small pea, which made its way out at the little wound. The final result was complete obliteration of the *nævus*.

Carcinoma rarely commences in the lids, although it may spread to them from other parts. Should it be already far advanced when first brought under the surgeon's notice, extirpation would hardly be attempted. Small, hard, suspicious growths at the margin of the tarsus may be removed by

excising a wedge-shaped portion of the lid on which they grow, and then uniting the wound with sutures.

Epithelial cancer chiefly attacks the skin over the lacrymal sac, and from that point extends over the nasal and superior maxillary bones, having the appearance of a shallow pale ulcer, with an irregular outline and uneven borders, and with a scarcely perceptible quantity of secretion. Chloride of zinc, made into a paste, and applied over the entire surface of the sore, so as to include its edges, will sometimes very effectually destroy the morbid growth, and it may be reapplied whenever any part of the border of the sore begins to exhibit fresh activity. Of course, the strictest attention to general health would be combined with the local treatment.

INJURIES OF THE LIDS.

Echymosis.—An effusion of blood into the areolar tissue of the lids, popularly termed ‘a black eye,’ is commonly the result of a blow; but it may arise from other causes, as, for instance, from the unskilful employment of leeches. The sufferer is always most anxious to get rid of the echymosis as quickly as possible; and I know of no treatment so efficacious as that handed down by the traditions of pugilism, consisting in the application of a poultice formed of the freshly-scraped root of the ‘black bryony’ (*tamus communis*), mixed with a due proportion of linseed-meal or bread-crumbs. Poultices of this kind produce a stinging sensation in the skin, and, if regularly applied for a day or two, seldom fail in effecting a complete absorption of the effused blood.

Emphysema.—This, like echymosis, is usually the result of a blow with the fist, which fractures some of the thin brittle bones, such as the lacrymal or ethmoid, forming the inner wall of the orbit. If, shortly after such any injury, the patient blows his nose, the eyelids suddenly puff up, so that he is unable to separate them. On pressing the part with the fingers, we at once perceive the peculiar crackling caused by the presence of air in areolar tissue. If the patient abstain from blowing his nose, the effused air soon becomes dispersed, and the swelling disappears.

Wounds of the lids have already been considered.* They are

* See INJURIES OF THE FACE.

to be treated on the common principles of surgery which apply to other regions. The careful surgeon would naturally be alive to the importance of obtaining the nicest adaptation of cut surfaces in parts so open to observation. The yielding nature of the skin of the lids, and its plentiful supply of blood, offer peculiar facilities for effecting close and smooth union of wounds by means of fine sutures, in applying which the greatest care must be taken to avoid any irregularity and puckering of the cut edges.

CHAPTER XIII.

DISEASES OF STRUCTURES WITHIN THE ORBIT.

STRUCTURES very dissimilar, as regards their nature and functions, are grouped together in the present chapter; but they are all more or less concerned in supporting or imparting motion to the eyeball. The various morbid growths within the orbit, which cause displacement or impair the mobility of the organ, are also here briefly noticed.

PROTRUSION OF THE EYEBALL.

(*Proptosis oculi; Ophthalmop-tosis; Exophthalmos.*)

Various causes may induce an unnatural prominence of the eyeball; but cases are sometimes met with in which this prominence seems of itself to form the whole morbid condition. The eyes have a remarkably staring expression, and look as if they were much too large for their sockets. The tarsi can be brought into contact; the eyes themselves move freely in all directions, and sight is unaffected. The equal amount of prominence in both eyes, and their unimpaired functions, at once remove any suspicion of orbital tumour.

Women of feeble and hysterical constitution, and those affected with bronchocele, are the usual subjects of this deformity, the cause of which is very obscure. Atony of the recti muscles has been suggested; and no doubt a weakened state of these muscles might produce a certain amount of prominence of the eye, but would be incompatible with its free motion. I have never seen any cure or benefit result from treatment in these cases of proptosis.

Dislocation of the eyeball from the socket is an accident we often hear of, but I need hardly say, that without rupture of the optic nerve the eye cannot be thrust upon the cheek, where it so often figures in the exaggerated accounts of patients. What really takes place is, probably, the lodgment of the upper lid behind the greatest convexity of the globe. I have seen this accident occur, when a surgeon, anxious to explore the upper surface of the sclerotic, in search of a foreign body, or for some other cause, has too forcibly thrust back the upper lid. The tarsus, being forced beyond the summit of the eyeball, has suddenly slipped backwards, and become fast locked behind it. A wire elevator or a bent probe will enable the surgeon to lift up the tarsus and restore it to its place.

Hydatids, cancerous growths, and exostoses, by encroaching upon the cavity of the orbit, all give rise to gradual displacement of the eyeball. As this displacement increases, the movements of the eyeball become more and more limited, until at last it remains quite fixed.

It requires much careful investigation into the history of the case to enable the surgeon to determine the nature of the morbid growth. Exostoses are the slowest, and encephaloid tumours the most rapid in their progress. It is sometimes possible to pass in the tip of the little finger between the globe and the anterior edge of the orbit, and thus partially to explore the surface of the tumour. Hydatid cysts are recognised by a feeling of elasticity and fluctuation; and in doubtful cases a puncture with a fine trocar will sometimes reveal the true nature of the mass.

The removal of morbid growths from the orbit requires the utmost care, to avoid inflicting injury upon the eye itself or the optic nerve; and, before attempting such an operation, the surgeon should be well convinced that the mass is limited to the orbit, and has not extended into it from the cavity of the skull.

Abscess in the orbit occurs as a result of injury, such as the entrance of a foreign body; or it sometimes seems to be the effect of a chill. In a less acute form we meet with it as a sequela of fever and erysipelas. The suppuration is ushered in with rigors and depression; the conjunctiva and areolar tissue of the globe are red and infiltrated, the lids swollen and livid; the

tuation can be detected by the finger passed in between the lids and the globe. The rapidity with which these symptoms follow each other would serve to distinguish suppuration from the growth of a tumour. Until fluctuation occurs, the existence of pus in the areolar tissue of the orbit is very obscure; and the deep exploratory punctures which some surgical writers advise to be made between the eyelids and the globe must be very unsafe, considering how closely the eyeball is surrounded with muscles and nerves, which random incisions would endanger. A careful surgeon may sometimes succeed in safely opening a deep orbital abscess; but I have known a total division of the optic nerve to result from an over bold incision.

Chronic abscess in the orbit is commonly the result of caries or necrosis; and the denuded bone will be felt by introducing a probe through the opening by which the pus has been evacuated.

Orbital abscess, even of the acute and so-called phlegmonous kind, so commonly occurs in depressed and feeble subjects, that light and nutritious diet, with a due proportion of stimulants, will be indicated instead of abstinence and leeches. The bowels should be rapidly unloaded, and then narcotics given in doses just sufficient to soothe pain and induce sleep. Bark and ammonia, wine and other tonics, will often be needed in increased quantities during the free suppuration, which not uncommonly follows the opening of the abscess. Warm water-dressing will be throughout the best local application.

AFFECTIONS OF ORBITAL NERVES.

The eyeball and its appendages derive their sensibility from branches of the ophthalmic division of the *fifth* nerve, which not only endows these parts with feeling, but also so far influences their blood-supply that total anæsthesia of the nerve is followed, sooner or later, by deranged nutrition of the cornea, and by other phenomena generally described as ‘inflammatory.’

These phenomena have been already noticed in the Chapter treating of Diseases of the Cornea; and at present we may confine our attention to those motory nerves which supply the muscles of the lids and globe,—namely, the third, fourth, sixth, and ‘*portio dura*’ of the seventh, or facial.

The orbicularis palpebrarum is supplied by the last-named nerve, and when this is paralysed, the tarsi can no longer be brought into contact. If the patient is told to shut the eye, the lids remain immovable, if the paralysis is complete; or if it be

only partial, a slight attempt at closure takes place. At the same time the eyeball is rolled upwards by the action of the superior rectus, as if seeking in that way the shelter of the upper lid. Sometimes the branch supplying the orbicularis palpebrarum is alone paralysed, but more frequently this is affected in common with the other facial muscles.

The orbital nerves, it will be remembered, are distributed as follows : the third to the levator palpebræ, the superior, inferior, and internal recti, and inferior oblique muscles ; and also to the iris, through the medium of the ophthalmic ganglion. The fourth nerve supplies the superior oblique, and the sixth the external rectus.

It is not necessary that all the muscles supplied by one of these nerves should be affected at the same time, or to the same extent ; but for the sake of illustration we will assume cases in which the various nerves have wholly lost their motory function.

The following are the symptoms of paralysis of the *third* nerve. The upper lid hangs motionless, and is in contact with the lower one (*ptosis*). On lifting it we find the globe abducted, so that the cornea is turned towards the temple. The patient can direct the eye still farther outwards, but neither inwards, upwards, nor downwards. The pupil is dilated and fixed, and on that account vision, especially for near objects, is somewhat impaired, although the optic nerve and retina may be wholly unaffected. By looking through a small aperture vision becomes perfect. If the patient looks with both eyes at objects placed on that side of him towards which the affected eye is abducted, they appear single ; while objects in the other direction appear double. If all the branches of the third nerve are paralysed, the inferior oblique muscle of course ceases to act, and the superior oblique having no antagonist, rotates the globe on its antero-posterior axis, and hence vertical objects seen with the affected eye appear oblique.

If the *sixth* nerve alone be paralysed, the eye is turned inwards. This inversion can be increased at will, and the eye can be freely moved upwards and downwards ; the pupil is of natural size and active, and the upper lid retains its motions unimpaired. If the patient looks at objects on that side towards which the eye is inverted, they appear single ; but objects in the other direction are double.

Paralysis of the *fourth* nerve is much less common than either

of the two forms already mentioned, and, on account of the very slight change it causes in the position of the eye, is very difficult of detection. The paralysis is chiefly to be recognised by its subjective phenomena. If, for instance, the patient with both eyes open fixes his attention on some straight line on the ground, as the edge of a gravel-walk, or the curb-stone of a foot-pavement, he sees two lines, one in its real position, and the other forming with it a more or less acute angle. If with both eyes he looks at a near object, such as a large capital letter, at such an angle that it appears double, the image perceived by the affected eye will incline from the perpendicular, and its lines cannot be brought parallel to those seen by the sound eye, unless the patient inclines his head to one side. The letter T or a +, as containing right angles, are good forms for testing the defect.*

The *treatment* of paralytic affections of the orbital nerves must be based on a careful investigation into the symptoms of each individual case, for the causes of paralysis may be very various. Slow, and eventually total, paralysis of one or all the nerves which enter the orbit may depend upon chronic changes in the brain itself, or the dura mater, the growth of tumours, disease of bone, &c. Sudden paralysis may follow apoplectic effusion or other injury to the cerebral structure, or may depend upon rheumatic inflammation of the fibrous tissues immediately surrounding and investing the nervous trunks.

Of course the prognosis would vary greatly accordingly as one or another of these causes had induced the paralysis. In the case of chronic brain-disease, or the growth of intracranial tumours, the treatment could be only palliative. The probability of recovery in cases of apoplexy would depend upon the extent of the extravasation.

If one or more of the orbital nerves were suddenly paralysed, and at the same time other parts of the body were affected with loss of motory power, while the brain itself gave evidences of its whole circulation being disturbed,—there would be comparatively little chance of the orbital muscles recovering their function. But if the paralysis were so completely limited to one of the orbital nerves as to render it probable that only some minute vessel in the course of the motor-tract had given way,

* The use of the oblique muscles appears to be to maintain the eyeballs in such a position that their vertical diameters may be always kept parallel to each other during lateral inclination of the head.

and had involved the adjacent brain-fibres, the absence of all other cerebral symptoms would warrant the hope that considerable improvement, or even complete recovery, might take place.

By far the most hopeful cases are those where the paralysis of the orbital nerve can be traced to rheumatism; since a well-directed treatment of the general rheumatic diathesis will, in all probability, restore the affected nerve to a healthy condition.

This seems to be the most fitting place for saying a few words about the affection termed *Mydriasis*; for although its manifestation is wholly in the iris, yet the morbid appearance is caused by a loss of motory power in certain branches of the third nerve.

In *Mydriasis* the pupil is dilated and immovable; and as such a condition is attended with some indistinctness of sight, it often gives rise to extreme alarm, and is regarded as a symptom of 'Amaurosis.' A simple experiment, however, suffices to determine the real nature of the case. Let the patient supply the want of a contracted iris by looking through a small aperture, such as a pinhole in a card held close to the eye. If the case be one of *Mydriasis*—dilated pupil, with a sound retina—he will see perfectly; but if the retina be affected, the aperture will either be quite useless, or at the utmost, afford very little assistance.

The *treatment* of *Mydriasis* is not easily reduced to precise rules, as the affection may originate in various ways. Exhaustion of nervous energy, dyspepsia, intestinal irritation from worms, &c., rheumatism—all seem in turn to be the exciting cause. Tonics, alone or in combination with purgatives, colchicum, strychnine, as an internal medicine, or applied 'endermically,' powdered ergot of rye, snuffed up the nostril of the affected side,—all these and other means have been employed with but little success. The discovery of the remarkable property of the Calabar bean has at once placed at our command a substance which induces contraction of the pupil as completely as atropine dilates it; but I have not met with a case of true mydriasis in which the Calabar bean, however efficacious at the time, has produced a permanent cure. It is best used by means of little disks of gelatine, on the principle invented by Streatfeild for the application of atropine.

A very contracted and immovable state of the pupil is described

by some writers under the name *Myosis*, but it is seldom met with as a simple and independent affection. Some persons who have naturally very small pupillary apertures enjoy such excellent sight, that we must be cautious how we call such a state of the pupils morbid. Extreme contraction of the pupil, however, is a symptom of irritation of the sympathetic nerve; and it would therefore induce the surgeon carefully to examine the condition of this nerve in the neck, as being possibly pressed upon and irritated by some tumour or morbid growth.

STRABISMUS.

The various forms of mal-position of the eyeball just noticed, depending upon more or less sudden paralysis of the ocular muscles, might, according to strict etymology, be classed under *strabismus*; but, practically, the term is restricted to those chronic cases in which habitual mal-position results from irregular action of either the internal or external rectus. The deformity may be defined as a faulty position of the eyes, whereby a separate image falls upon each macula lutea, when the patient endeavours to direct both eyes to one object at the same time.

Strabismus may be either *convergent* or *divergent*. In the former case the eye, or eyes, will be directed towards the nose: in the latter case towards the temple. The strabismus is termed 'single' if one eye only is misplaced, and 'double' when both eyes converge or diverge. In many cases which ordinarily appear as double strabismus, one eye becomes perfectly straight whenever the patient fixes his attention on an object; and the eye which thus for a time acquires a normal position will be found to have the stronger powers of vision.

In other instances of double strabismus both eyes maintain their inverted position, even while the patient is intently observing an object; but if the surgeon suddenly closes one of these convergent eyes, the other at once becomes straight, resuming its inversion as soon as the other eye is opened.

Donders has shown that in the great majority of instances convergent strabismus is associated with hypermetropia; and the divergent form with myopia. Divergent strabismus however is rare, except as a consequence of considerable loss of sight in one eye, persisting for several years.

The *causes* of strabismus are very various. When existing

only to a slight degree, coming on only occasionally, and alternating from one eye to the other, it will sometimes be found due to intestinal irritation, such as that arising from worms. In other cases, it may be traced to the temporary cerebral disturbance induced by teething, or to the more persistent form which attends hydrocephalus. An opacity near the centre of the cornea will sometimes cause an eye gradually to turn inwards through a sort of instinctive effort of the organ to bring a clear portion of the cornea into use.

The *treatment* of strabismus, as will be evident from what I have just said as to its causes, must vary according to circumstances. The removal of intestinal irritation; the use of tonics; the employment of convex glasses, to correct extreme hypermetropia;—these, and many other means, may be useful to control strabismus which is only temporary, or which arises from peculiarity in the visual focus of the eyes. In every case a careful ophthalmoscopic examination is the first duty of the surgeon; and he should also take every possible care to ascertain that no organic disease exists in the brain or orbital nerves, and that there is no tumour in the orbit mechanically hindering the movements of the eye.

The *operation* for the cure of strabismus consists in the division of the muscle, which, in consequence of shortening, or too great preponderance in contractile power, is permanently drawing the eye either inwards or outwards. Division of the internal rectus, when first introduced, was performed in the following way. The lids being held apart by an assistant, a small sharp hook was stuck into the sclerotic, close to the inner margin of the cornea, so as to fix the eyeball and draw it outwards. Then the surgeon, raising with a forceps a fold of conjunctiva midway between the cornea and plica semilunaris, divided it vertically with scissors, snipped through the sub-conjunctival tissue covering the tendon of the muscle, passed under it a blunt hook or director, and upon this divided with scissors, or with some kind of knife, either the tendon itself or the adjacent muscular portion of the rectus internus.

As in all other instances of manual surgery, the apparatus for performing this operation gradually became simplified. The spring speculum superseded the elevators held by an assistant; the sharp hook for fixing the globe was laid aside; and it was found that all the cutting could be done with scissors alone. The curious little knives, in every variety of form, which had

been invented for dividing the muscle, are now for the most part forgotten ; as are also the unseemly disputes about priority in trifling discoveries, and the exaggerated accounts of the uniform success which was stated to have attended the practice of certain strabismus operators.

The defects of this earliest form of operation were a too great separation of the ocular conjunctiva, inducing a subsequent retraction of the semilunar fold, and an over weakening, amounting sometimes to utter loss of action, in the divided muscle.

We still occasionally meet with a fixed and leering eye which recalls the period of the first introduction of the operation in 1840 ; when, without the ophthalmoscope to facilitate diagnosis, every tyro fancied himself competent to cure a squint.

The deformity arising from retraction of the semilunar fold is now in a great measure obviated by sub-conjunctival division of the muscle. The lids are kept asunder with a spring speculum ; and an assistant draws aside the globe, by nipping up with the forceps a little fold of loose conjunctiva near the margin of the cornea, at the opposite side to that on which the muscle is to be divided. Supposing the internal rectus to be chosen for operation, the surgeon, with scissors, divides the ocular conjunctiva horizontally, on a level with the lower edge of the cornea, and extends the incision towards the semilunar fold. Then he snips through the sub-conjunctival tissue, and having clearly exposed the sclerotic, slides upwards, between it and the rectus, a curved director. This serves to raise the muscle and make its fibres tense, and then with scissors the muscle is carefully cut through, close to its insertion into the sclerotic. This section of the muscle cannot be completed at a single stroke, but requires repeated use of the scissors, so that no fibres may be left undivided.

While this sub-conjunctival operation through a horizontal external wound obviates the retraction of the semilunar fold, it involves the risk of an imperfect division of the muscle, which is not exposed to the view of the surgeon. A careful exploration with the blunt hook or director must be made to detect any undivided fibres, before the spring speculum is finally withdrawn.

Graefe divides the conjunctiva a little below the equator of the globe and a few lines from the cornea, almost over the insertion of the tendon ; exposes the sclerotic just enough to pass a curved blunt hook beneath the tendon, which is drawn well into

the conjunctival wound before using the scissors. It is then snipped through close to its sclerotic attachment; care being taken that the hook, which is sharply curved, is not allowed to perforate the tendon, but is passed well under it. In this operation the tendon is brought quite into view, and is not likely to escape division, which is one of the dangers of the sub-conjunctival operation.

In dividing the *external* rectus, it must be borne in mind that the muscle is broader than the internal rectus, and is also inserted farther from the corneal margin.

Most cases of strabismus require the division of each internal rectus, even when the inversion of the better eye is but slight in comparison with the other. Instances, however, occur in which the inversion is wholly confined to one eye; and in such a case the faulty eye may alone be operated upon.

No absolute rule can be laid down as to the use of chloroform in strabismus operations. In most cases it will be found necessary; but where patients are fitted by age, intelligence and self-command to undergo the operation without it, the doubt which sometimes exists as to whether the muscle has been effectually divided can be at once solved, by directing the patient to attempt inversion of the eye; a test we are unable to employ when insensibility has been induced.

When, in searching for the muscle, the sub-conjunctival areolar tissue has been largely separated, it becomes infiltrated with blood, and forms a little prominence in the wound. The blinking of the lids gradually moulds this into a small button-shaped excrescence, attached by a narrow pedicle, which may be snipped through some weeks after the operation.

REMOVAL OF THE EYEBALL.

Certain diseased conditions of the globe may require a portion of it to be removed, while in other cases its tissues may be so extensively involved, and so much constitutional disturbance may in consequence arise, as to render necessary the total extirpation of the whole organ.

In non-malignant cases this operation is usually undertaken with a prospect of the patient afterwards wearing an artificial eye; and it therefore becomes important to consider whether a total or a partial extirpation will be best adapted to the end in view.

The enlargements which call for removal, on account of the deformity they occasion, are chiefly staphylomatous projections of the cornea or the sclerotic. Under the former term are commonly included projections which have really little or no corneal tissue within them, being formed of the iris coated over with fibrous tissue, after the true cornea has been partially or wholly destroyed by ulceration or sloughing. The sclerotic staphylomata, as they are called, are produced by gradual thinning and distension of the weakened fibres of the part from accumulation of aqueous humour or of serum. In some of the latter cases the eyeball acquires a very large size, and is extremely unsightly, on account of the dark leaden-coloured projections of the sclerotic, and the large tortuous veins which ramify over it. When the cornea has been extensively destroyed by sloughing or ulceration, it very commonly happens that the lens escapes through the breach; when this does not take place, the lens frequently becomes filled with a deposit of phosphate of lime, and this earthy mass, by pressing against the ciliary processes and iris, often causes severe neuralgia. In excising a staphyloma, therefore, the opening should be made sufficiently large to allow the lens, if still existing, to escape.

In operating, the lids must be held apart with a spring speculum or the fingers of an assistant. The surgeon then passes a cataract-knife through the staphyloma, and forms a flap, which he seizes with a forceps, and removes with a second stroke of the knife; if the lens presents at the opening, it is to be quickly tilted out with a scoop, and then the lids are instantly to be closed, and a cold sponge applied firmly over them. This immediate pressure is the most likely means for preventing hæmorrhage from the enlarged choroidal vessels, which sometimes give way the moment the fluid contents of the globe have escaped. Moderate pressure should be kept up until the risk of bleeding has gone by, and then water-dressing will be the only application required till the parts are healed. The portion of the globe left after the excision of a staphyloma gradually shrinks to a nodule, and as soon as this has ceased to be tender, an artificial eye may be applied.

If, in consequence of the sudden removal of the pressure which the accumulated fluids of the globe had been exerting on the choroidal and retinal vessels, the latter give way, and blood fills and distends the cavity of the sclerotic, extreme pain is the result, and it may even be thought desirable at once to

extirpate all that remains of the globe, with the view of preventing future suffering. With the object of obtaining a better stump on which to wear an artificial eye, Critchett has modified the operation for staphyloma as follows. He passes several curved needles armed with threads through the sclerotic, above the base of the staphyloma, quite into the vitreous chamber, and brings out their points at the opposite side of the projection. He then cuts away an elliptical portion from the front of the mass, draws the ligatures quite through, and ties them in knots, which then lie just across the line of the closed incision.*

Total extirpation of the eyeball.—This operation, except when malignant disease exists, should never be resorted to, so long as any sight remains in the organ; unless it should be so irritable as to lead the surgeon to fear that, by sparing it, the sight of the fellow-eye may be endangered. Restricted within due limits, and not undertaken through a morbid love of operating, extirpation of the eyeball is a ready means of relieving patients whose whole system may have become impaired by long-continued neuralgia, arising from distension of the globe, or lodgment of foreign bodies within its cavity.

The operation, which was formerly effected by scooping out all the contents of the orbit, has been greatly simplified by the adoption of Bonnet's method, in which the globe alone is removed. A circular incision is made through the conjunctiva and ocular fascia, and then each muscle of the eyeball is successively divided close to its insertion, and the optic nerve just before it pierces the sclerotic.

The operation is usually performed by raising with a hook all the tendons of the ocular muscles, and dividing them before cutting through the optic nerve.

I prefer the following plan, as simpler and more rapid. Having inserted the spring speculum between the lids, and made with curved scissors the usual circular incision of the conjunctiva, I grasp the external rectus and its surrounding tissue with a forceps, and snip them through; an assistant at once seizes the cut tendon close to its insertion, and draws the eye inwards. By sliding one blade of the scissors under the superior oblique and rectus muscle, they can be divided, and then the inferior rectus. The optic nerve is next snipped

* *Ophthalmic Hospital Reports*, vol. iv. p. 1.

through, and the globe starts forward. A few strokes of the scissors divide the inferior oblique, internal rectus, vessels, and bands of areolar tissue, and the operation is completed. Cold water and exposure to the air suffice to arrest the bleeding, and then water-dressing is all that is required.

USE OF CHLOROFORM IN OPHTHALMIC SURGERY.

We may regard chloroform under two aspects: as saving the patient from pain, and as facilitating the manipulations of the surgeon. Now it is well known that operations performed on the globe itself cause little pain, and last but a very short time. Those on the lids, involving as they do the wounding of skin, are of course more painful; but none of them are in this respect comparable to the larger operations of general surgery; and there are few adults who, if properly informed as to the real nature of such operations as those for cataract, artificial pupil, and strabismus, will not readily undergo them without the aid of anæsthetics. There are, however, many timid and anxious persons who are quite unable to go through the operations for artificial pupil and strabismus except under chloroform, and very few without its aid can encounter extirpation of the eyeball. It is also occasionally necessary to induce insensibility in order to examine eyes rendered irritable by disease, or by the presence of foreign bodies. In children all ophthalmic operations are greatly facilitated by the use of chloroform, and some can hardly be performed without it.

If a perfectly passive condition of the eye is so desirable during the delicate operation of flap-extraction, one would naturally expect to find chloroform peculiarly indicated in such a case. But it forms, I think, a special exception, for the following reasons. We have already seen (p. 186) that, when this operation of extraction has been properly performed, a successful result chiefly depends upon the rapidity with which union of the corneal wound can be effected. Now, with every precaution in the administration of chloroform, it will occasionally induce sickness; and the effort of vomiting may cause the vitreous body to escape through the opening just made in the cornea, thus inducing prolapsus iridis, with all its consequent irritation and hindrance to union of the wound. But, even without assuming so extreme a case, we shall find a very serious objection to chloroform in the nausea and disrelish for

food which often follow its inhalation, whereby the nutrition and reparative power of the cornea become impaired during the critical twenty-four hours immediately succeeding the operation.

JAMES DIXON.

DESCRIPTION OF PLATES.

The more experience one has had with the ophthalmoscope, the more one feels the impossibility of illustrating by any single drawing the normal fundus of the eye. So many variations of form and colour are compatible with good sight, that such a single drawing can merely serve as a rough indication of what a beginner with the ophthalmoscope is to look for in his first examinations.

Plate I., fig. 1.—A plan of the healthy fundus of the eye in a person of fair complexion. The optic nerve and the yellow spot are not really to be seen at one view, as they are here represented. To see the former the surgeon must tell the patient to turn the eye a little inwards; but to look directly forwards when the yellow spot is to be examined. In persons of fair complexion the site of the spot is usually marked by a tint redder than that of the neighbouring retina, and it is not crossed by any large artery or vein. The fundus of the right eye, which is here represented, is shown reversed, as in the indirect examination, so that the yellow spot, which is really external to the optic nerve, appears to its inner side. (See p. 24.)

Fig. 2.—This is a diagram, not a drawing from nature. It shows in a rough manner the abrupt curving of the vessels, the concave form of the optic disk, and the grey tint which the latter sometimes assumes in the very advanced stage of true glaucoma, or of grey atrophy of the optic nerve. Such a change in the nerve as is here shown, in respect of its outline, its concavity, and its colour, would only be met with when disease—such as chronic glaucoma or primary grey atrophy—had existed a long time. Curving of the vessels, but to a much less extent than is here shown, and with less, if any, change of outline in the disk, is met with during the preliminary stage of glaucoma. The appearances during the acute stage of an attack cannot be depicted, because the change in the corneal epithelium, and the cloudiness of the vitreous humour, which accompany that condition, prevent a clear view of the fundus being obtained. Mr. Burgess is not responsible for these two figures, which are from drawings of my own.

Plate II., fig. 1, shows numerous patches of absorbed choroid, with pigment deposits, from a woman, aged thirty-eight, who, eight or nine years before, had suffered from syphilis. (See p. 107.)

Fig. 2.—Extreme pigmentation of the retina in a man of fifty, who was nearly blind from 'retinitis pigmentosa,' which had been gradually advancing from childhood. The two eyes were almost exactly alike. The optic nerve was pale; and the retinal vessels were very much diminished in size. (See p. 129.)

Plate III., fig. 1, is intended to show the appearances presented by the choroidal vessels when they are exposed to view by the absence of that layer of cells which in a healthy state is interposed between the choroid and the retina. In this figure isolated patches of this layer are still to be seen. The choroidal vessels are represented as rather too uniform in size, but their closely set meshes, with the intervening masses of black pigment, present a marked contrast to the long isolated vessels of the retina. (See p. 26.)

Fig. 2 shows very well the homogeneous white disk and contracted vessels of an optic nerve which has undergone 'white atrophy.' (See p. 124.)

PLATE I.



Fig. 1.



Fig. 2.





PLATE, II.



Fig 1.

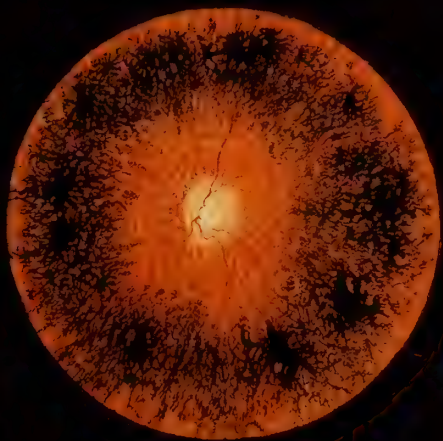


Fig 2



PLATE. III.

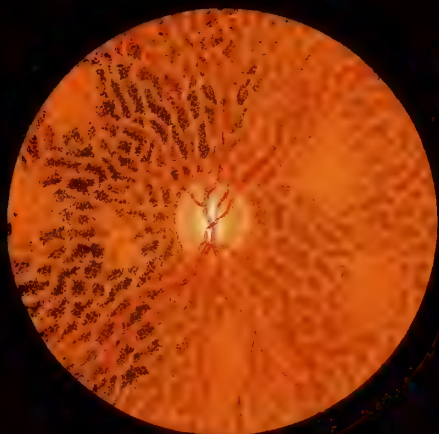


Fig. 1.

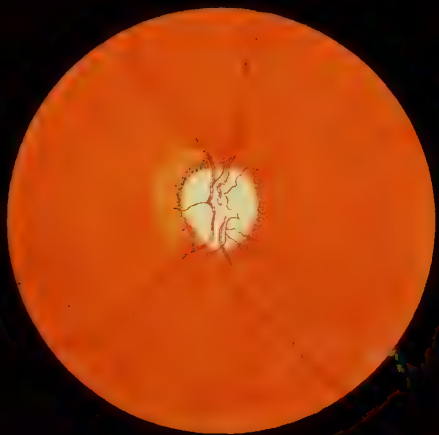


Fig. 2

DISEASES OF THE EAR.

THE diseases of the Ear naturally divide themselves into three classes, in conformity with the anatomical structure of the organ—those of the external, of the middle, and of the internal ear. The first class includes the affections of the auricle and of the external meatus; the second, those of the membrana tympani, tympanum, mastoid cells, and Eustachian tube, with the adjacent regions of the throat; the third embraces the diseases of the labyrinth and of the auditory nervous apparatus, so far as it comes within the reach of our investigation. In addition to these, certain diseases not capable of strict local definition, and the effects produced upon the brain and other organs, chiefly the lungs, by inflammation commencing within the ear, will require description.

I. AFFECTIONS OF THE EXTERNAL EAR.

Malformations.—The surgeon is occasionally consulted for external malformations of the ear. These vary in extent from an entire absence of the meatus and its appendages on the one hand, to the presence of a double set of organs on the other. The most frequent malformation is an imperfect development of the meatus and auricle; the former being reduced to a narrow slit in the temporal bone, and the latter existing only as a slight fold of the integument. The tympanum also, in some of these cases, is merely rudimentary, consisting of an irregular aperture a few lines in diameter, and the ossicula are more or less defective. Sometimes a single bone, resembling the columella of birds and reptiles, takes their place. The labyrinth is in these cases most frequently normal, and a certain amount of hearing is usually present; often it is so considerable as to enable the patients to perform useful duties. For the most part extensive deformity is present, from absence or defect of other portions of the skull, as the malar bone, or

the zygoma; and the orifice of the meatus may seem to lie very much anterior to its normal position. Operative proceedings have not been found beneficial in these cases, nor in those in which, with a more or less perfectly formed auricle, the cartilaginous portion of the meatus is also perfect but ends in a cul de sac. The bone beneath is generally found solid. In another class of cases, however, in which the defect is confined to a contraction of the meatus at its orifice, from a falling back of the tragus, or projection forwards of the antitragus, efficient assistance can be rendered by the prolonged use of a tube adapted to the size of the canal; or excision of a portion of the offending cartilage. Congenital closure of the meatus by a false membrane, sometimes superficial, sometimes deeply seated, near the membrana tympani, is said to have occurred, and to have been remedied by the division of the structure, followed by the introduction of tents.

Supernumerary auricles are sometimes met with, growing from the sides of the neck.

In the ninth volume of the *Transactions of the Pathological Society*, Mr. Birkett relates a case of this kind. The structures consisted partly of a tissue like the lobe of the ear, and partly of fibro-cartilage, the shape of which 'resembled more or less closely, in parts, that of the proper auricle; and its tissues were the same.' They were excised without difficulty, and appeared to be merely cutaneous appendages, not extending more deeply than the fibres of the platysma myoides.

Injuries of the auricle, and the lodgment of foreign bodies in the meatus, will be found treated of in the essay on INJURIES OF THE FACE.

The auricle is subject to various *cutaneous affections*, herpes, impetigo, pemphigus; but the most important are chronic erysipelas and chronic eczema. Both these conditions are most frequent in women past middle age, though the latter is also met with in children. In chronic erysipelas the entire auricle becomes greatly thickened, so that its outline is almost lost. The skin is red, dry, and hard, and covered with desquamating epidermis. The swelling encroaches on the meatus, the orifice of which is narrowed and frequently obstructed with epidermis. There is constant itching, but not much pain, though the parts are tender. Sometimes the affection dates from a previous attack of acute erysipelas, extending over the side of the head; sometimes it seems to be local from the first. The health is

invariably deranged. The *treatment* consists first in cleanliness, the discontinuance of wrappings, and free exposure of the parts to the air. When the inflammatory thickening and irritation are considerable, poultices may be applied at night. A continued use of astringent lotions is needed to restore the healthy action of the skin. A solution of nitrate of silver (gr. v.—ʒj. to ʒj.), used alternately with others, has considerable effect. Glycerine is often very soothing; or the ear may be covered with collodion, renewed daily. The constitutional treatment should be conducted on the usual principles. Debility is generally, but by no means always, present. A permanent contraction of the meatus sometimes results from this disease. Its effects may be mitigated by wearing a small silver tube accurately fitted to the parts.

In chronic eczema the auricle presents less thickening than in the last-mentioned affection; but it is considerably swollen, covered more or less with brown or yellow crusts, and, when these are not present, exudes a watery fluid. A similar eruption is generally present on the scalp, or on other parts of the body. The diseased condition mostly extends into the meatus, and more or less deafness is present. It is attended with great itching. The membrane is generally somewhat reddened and swollen. The *treatment* is the same as for other forms of eczema; but the meatus should be well syringed out with warm water frequently, to prevent discharge from accumulating within it, and in the later stages of the disease may be washed with a solution of the nitrate of silver, or with citrine ointment diluted with glycerine or almond oil. If, after the eruption has ceased, there remain any degree of hardness of hearing, dependent upon a thickening of the membrana tympani, the case would come within another class of affections—those of the middle ear.

Gouty deposits are met with in the auricle; and congestion of the cartilage, arising from the same cause, is sometimes met with. Excoriations are not uncommon in children; but they are readily cured by cleanliness, with or without mild astringent lotions. Great care should be taken to dry the ears and hair of children after washing. In inflammatory affections of the auricle or meatus the glands beneath the angle of the jaw generally become somewhat swollen and tender; occasionally suppuration occurs in them. Paralysis of the facial nerve may result from their pressure.

Tumours of the auricle.—Of these three chief forms have been described:

1. A fibrous growth of great hardness, forming in the cartilaginous portion, and giving rise sometimes to great inconvenience. This is rare in England, but in the *American Journal of Medical Science* for October 1860, it is stated to be much more common in negroes. Fibrous tumours also form in the lobe, around the hole from which the ear-ring is suspended. In either case they are easily removed.

2. Cystic disease. Under this name two distinct affections have been described: one consisting of a sac containing a glairy tenacious substance, the other being an infiltration of the tissues of the auricle with a sanguinolent fluid. The latter is the disease met with so frequently in the insane, known under the name of hæmatoma auris. Whether this affection arises from injury is still a matter of discussion among those who have charge of the insane. For treatment, Dr. Thurnam (as quoted by Mr. Toynbee) recommends, in the acute stage, ‘the use of evaporating lotions; at the end of a week or two a seton should be passed through the long axis of the swelling, and the contents pressed out. Under the use of the seton the tumour gradually subsides.’ In the treatment of the ordinary cysts Mr. Wilde recommends that they should be laid freely open, and dressed from the bottom with lint.

3. Steatomatous and fatty tumours are also met with in the auricle, as well as a pendulous state of the lobe, which may reach an extreme degree, especially if goitre be present. This part is also subject to nævus, which may lead to its destruction to a greater or less extent; and erectile tumours have been met with in it, causing hæmorrhage. For the treatment of the latter affection, reference may be made to the section on VASCULAR TUMOURS in vol. i. p. 541.

II. AFFECTIONS OF THE EXTERNAL MEATUS.

In some cases in which this passage is wide and short, the greater part of it and the membrana tympani can be examined, by placing the patient in a good light, and gently elevating the helix with one hand, while the tragus is drawn forward with the other. For the most part, however, this is not possible, and a speculum is necessary. The best form is a silver tube,

of oval shape to fit the meatus, with its smaller end continued of the same diameter for about half an inch. This instrument, of which it is desirable to possess different sizes, admits the largest possible amount of light, and adapts itself easily and painlessly to the canal, in which it will remain fixed while the surgeon's hands are free. By moving it slightly in different directions the inner part of the meatus and the membrana tympani can be examined. A very good view may be obtained by causing the rays of the sun to fall through this speculum into the meatus, which may be effected by placing the patient in the sunlight, with his head inclined at a suitable angle but, as a rule, it is better to use a reflector, and employ the diffused daylight. If artificial illumination is necessary, it may be supplied either by means of a jet of gas conveyed by a flexible tube to a small stand furnished with a reflector, or by a reflector attached to an ordinary candle, or by the lamp invented by Dr. Chowne, and known as Miller's lamp. In using the speculum, the curve of the meatus forward should be remembered. In young children the meatus is very shallow, the osseous portion consisting only of a small ring of bone (deficient at the upper part), to which the membrana tympani is attached in a very horizontal direction. The speculum, therefore, should be used in their case with great caution. The points to be noted in the examination of the meatus are, the size and calibre of the canal, whether normal or infringed upon; the presence or absence of extraneous bodies and of cerumen; and the condition of the lining membrane.

Accumulation of cerumen.—The presence of wax appears to be only in a minority of instances the sole cause of the deafness that accompanies it. Mr. Toynbee found a perfect restoration of hearing effected by the removal of cerumen in sixty ears only out of 165.

Besides interfering with the hearing, accumulations of hardened wax may produce various ill effects. They may occasion (probably through pressure on the membrana tympani and ossicula) very distressing nervous symptoms; not only 'noises in the head' of various kinds, but giddiness, confusion, and even unsteadiness of gait, exciting the gravest apprehensions in the patient's mind. Further than this, they may even cause absorption of the bony walls of the meatus. This occurs especially in the old, in whom neglected accumulations have

existed for many years. In some cases of this kind the osseous plate that separates the cavity of the meatus from that of the mastoid cells is completely penetrated.

Deafness caused by cerumen for the most part presents peculiar symptoms, and a tolerably good diagnosis may often be based on the history of the case. The hearing generally varies; it is often better in the morning, or is improved by eating, or by rubbing the meatus with the finger. Very often it comes on suddenly, especially after exposure to cold. This is probably due to slight inflammatory swelling taking place in the meatus, and converting a partial into a complete occlusion. This circumstance has frequently led to the employment of the most misplaced depletory and other treatment in cases in which an inspection of the meatus has not been made. There is, however, another form of deafness which comes on suddenly after exposure to severe or long-continued cold, or cold and wet, and appears to depend upon an abolition of the function of the nervous apparatus. The great degree of the deafness, however, compared with the slightness of the apparent cause, together with the previous history, may serve to distinguish the effect of cerumen from the last-named affection. But it should be needless to remark that no treatment for any aural affection should be undertaken till a complete examination of the meatus has been made. If cerumen be present, it is best removed by syringing. The most efficient form of syringe is one fitted with a separate nozzle of small size, since a small jet of water acts more effectively, and presents less obstruction to the returning stream. The nozzle should be taken off each time the syringe is filled. If this form of syringe is not used, care must be taken that the meatus is not obstructed by the instrument. In syringing, the meatus should be straightened, by drawing back the auricle with the left hand, and gently pressing forward the tragus by resting the nozzle of the syringe upon it; my own practice is to direct the stream along the roof of the meatus. Care should be taken that the fluid is of the right temperature; it should never be below that of full blood heat. If too cool, or too hot, giddiness is produced. In ordinary cases, warm water only need be used. The use of the syringe should never be carried beyond a moderate extent at any one time, and should be discontinued if the patient complains of pain. It is much better to repeat the process several times than to run any risk of producing irritation, the effects of which are sometimes very difficult to allay. Cases

occur in which the most distressing and obstinate noises in the ears have supervened upon the removal of wax by the syringe; and in some of these I have found that even the most gentle employment of that instrument tends to aggravate the symptoms. If the wax is not removed in a moderate time, warm oil or solution of soda for a few nights will generally sufficiently soften it. This, however, is not always the case; sometimes the altered cerumen, mingled as it is with epidermis, is of almost stony hardness, and the parts at the same time are acutely tender, so that the most prolonged and gentle treatment is necessary to give relief. The ear should be frequently examined with the speculum, to ascertain whether any wax remains; since although the last portion generally comes away in a large mass, presenting a cast of the membrana tympani, this is not always the case. Small masses of hard cerumen sometimes collect in contact with the membrana tympani, and occasion much annoyance, in the form of itching and tinnitus. The speculum reveals the nature of the case, and syringing, which sometimes needs to be repeated, relieves it. A similar irritation may follow from the falling in of a hair upon the membrane; but probably in these cases there already exists a morbid irritability of the organ.

After the removal of cerumen, the membrana tympani is generally seen to be of a more or less sodden and opaque appearance, from thickening of its epidermoid layer; sometimes it is red and vascular. In many cases the hearing only gradually returns; and sometimes, when the immediate improvement has been but slight, it will rise by degrees almost to its normal amount. Time should therefore be allowed for this result before other measures are adopted. This affection is apt to return; nor have I seen sufficient evidence to show that applications to the meatus can ward it off.

Besides accumulation, the secretion of wax is subject to other disorders. In children it may become increased in quantity, fluid, and offensive; this being often the first stage of catarrhal inflammation of the meatus. In adults it is frequently entirely absent; but this is for the most part merely a concomitant of internal morbid conditions, and is itself entirely without influence on the function of the ear. Sometimes, though not always, the reappearance of the normal secretion attends or prognosticates a favourable issue of the case.

In the majority of the cases in which accumulations of wax

It is not uncommon to remove large masses of the latter, more or less mingled with cerumen. Sometimes an obstinate tendency to desquamation exists without any other apparent affection of the meatus, and this may or may not be accompanied by disease of the internal or middle ear. It may occur in connection with a general morbid irritability of the organ, or with tinnitus; and in the latter case the irritation of the loose masses of cuticle may aggravate the noises to a most distressing degree. The treatment in such cases must embrace the improvement of the general health and the strengthening of the nervous system. Local applications require to be very carefully employed. The ordinary astringents are ill borne. In this respect the condition differs from the common chronic inflammation of the meatus. A few drops of oil applied occasionally facilitate the removal of the flakes.

An enormous amount of injury is done by well-meaning nurses, who think the ears of children require to be cleared out by inserting into them the screwed-up corner of a towel. Dense masses of mingled secretion and epidermis become thus pressed down upon the membrane and often fatally injure it. I question indeed, whether this practice may not rank next to scarlatina among the causes of disease of the ear in children.

As long ago as 1844, Mayer reported a case of vegetable parasite in the external meatus, and recently, among others, Dr. Wreden has directed much attention to this subject.* The presence of the parasite is indicated by the production of dense white flakes within the meatus, which are obstinately reproduced. The membrane has never been found perforated, and no discharge is present. The growths hitherto met with appear to belong to *Aspergillus* and *Ascophora*, and both filaments and spores have been met with in great abundance. Dr. Wreden recommends as the best application a solution of hypochlorate of lime from one to two grains to the ounce. It should be pure and freshly dissolved in water. Liquor Plumbi in moderate solutions has also been found successful. I believe the affection is more common on the Continent than in England.

Abscess in the meatus.—This is an acutely painful, though not otherwise serious affection. It occurs generally in persons about

* Wreden, *Die Myringomykosis Aspergillina*, St. Petersburg, 1868.

middle life, and consists in the formation of one or more small abscesses in the outer part of the meatus. The affection is apt to recur, and may coincide with the formation of boils in other parts of the body. While the abscess is forming, there is acute pain of a throbbing darting character in the meatus, often extending over the side of the head. The parts are extremely tender, and the attempt to introduce the speculum causes great distress. The hearing may be temporarily impaired by narrowing or closure of the canal. Incision is generally the best treatment; but relief is given by the free use of poultices and fomentations, which should be applied as hot as they can be borne. In almost all these cases a similar constitutional treatment is indicated as for 'boils' on other parts of the body. When there has existed a tendency to their continued recurrence, the sesquioxide of iron in free doses has appeared to me to be useful.

Inflammation of the meatus.—This affection is either acute or chronic; it is frequently connected with diseased conditions of other parts of the ear, the membrana tympani, tympanum, and mastoid cells; in fact a discharge from the meatus should always excite suspicion of disease of the lining of the tympanum: but it sometimes exists without the presence of more deeply-seated disease, especially in its earlier stages. Neglected inflammation of the meatus, aggravated as it constantly is by confined and decomposing discharges, has a great tendency to spread inwards, especially perhaps in children and among the poor.

The early symptoms are similar to those which characterise the formation of abscess. The pain, however, is generally less acute; it is of a dull aching character, and is increased by motion of the jaw. The meatus is tumefied, red, and tender. After repeated attacks, it may be so swollen as almost to obliterate the canal, but no local swelling is to be observed. The neighbouring glands of the neck are often enlarged and tender. The hearing is not much impaired unless the canal is almost closed, or the tympanum implicated. The health is almost always disordered, and some of the severest and most obstinate cases I have seen have occurred in patients subject to gout. The access of the disease is generally attributed to cold, or blows on the head may occasion it. Sometimes there occurs at an early period of the affection an extremely profuse watery dis-

the skull; sometimes the inflammation subsides without any discharge; sometimes it is followed by a secretion of viscid mucus or of pus; or it may run into the chronic form of the disease.

In the *treatment*, the mere cleansing the meatus with warm water gives great relief, which is increased by hot fomentations and poultices, and it is probable that in some cases these means might suffice. The health, however, is generally more or less deranged, and the constitutional remedies either for debility or visceral derangement are indicated. Often also the severity of the pain demands local depletion, by leeches, around the orifice of the meatus (the passage being guarded by cotton-wool), and the employment of morphia in full doses to give rest.

After the inflammatory action has subsided, the ointment of the nitrate of mercury diluted with oil may be smeared over the surface of the meatus, or a solution of the nitrate of silver, five or ten grains to the ounce, applied with a camel's-hair brush. Care is needed to avoid a relapse.

A similar treatment is also often the most efficacious in the later stages of the *catarrhal* inflammation of the meatus, which is attended with more or less profuse semi-purulent discharge. But so far as I have observed, this condition is a concomitant of a similar affection of the tympanic cavity. Many cases also of apparent catarrh of the meatus are really cases of minute perforation of the membrane. In so far as the meatus is concerned, cleanliness is of course essential, and a mild use of astringents with discontinuance (as a rule) of the use of cotton-wool are to be recommended. But syringing by the patient or his friends is seldom effective, and is very apt to become a source of irritation. It is better to fill the ear a few times with any lotion and let it run out after one or two minutes; or if a syringe be used, the best form is a glass tumbler, into the lower part of which a flexible tube is introduced, the stream being made to flow by raising the tumbler. But the cases are very few in which the chief treatment should not be directed to the tympanum or throat. For healing the irritable surface of the meatus I have known the blowing in of powdered talc succeed after the most various moist applications had failed. The health being almost always deranged, especially in children, tonics are indicated; quinine, iron, and cod-liver oil. Mr. C. Forster speaks very highly of the effects of chlorate of potash given in free doses.

Chronic inflammation of the meatus sometimes follows the acute form of the disease; sometimes it results from repeated slight attacks. A common cause is the habit of prolonged bathing, or damping without drying the ears or hair. Without any considerable amount of pain, a feeling of uneasiness in the passage is complained of, a sensation of tension, and often of itching, prompting the patient to introduce pins or other substances with the view of allaying the irritation. This practice of course maintains and aggravates the disease. The meatus is swollen, and the epidermis becomes thick and peels off, often accumulating to a great extent. Sometimes the entire cuticular lining of the canal becomes loosened, and may be withdrawn in a form resembling the finger of a glove, the inner extremity presenting an accurate cast of the membrana tympani. In the worst cases the walls of the meatus are of a dusky-red colour beneath the epidermis, and tender. The wax is deficient, the hearing is most frequently impaired, and the membrana tympani vascular on its external surface. Indeed, this condition of the meatus seems seldom to exist without disease of the internal structures, the treatment of which is then of the primary importance.

Either of the above-described forms of inflammation may, in unhealthy subjects, extend to the osseous walls of the meatus, and give rise to caries or necrosis. This result is chiefly apt to occur in cachectic children.

Sometimes a considerable part of the wall of the meatus or of the mastoid process will come away; and it is remarkable to how great an extent this may take place without any considerable impairment of the functions of the ear. With the view of averting the extension of the disease inwards, the greatest care should be taken to secure a perfectly free exit for the discharge.

Syphilitic disease of the meatus.—This occurs chiefly in the form of fissures or of condylomata around the orifice. But I have seen another condition which appears also to be due to the specific poison. The meatus is ulcerated at its outer part, the ulcer having irregular edges and a foul surface, and a copious discharge flows from the passage. When it is cleansed, the speculum shows its surface reddened, and excoriated in parts; the membrana tympani is vascular. I suspect the disease results sometimes from the direct application of the poison.

some cases an enormous swelling of the auricle attended with ulceration occurs.

Polypi frequently have their seat in the meatus, but since they more often accompany disease of the tympanum they will be treated of hereafter.

Sebaceous or molluscous tumours are enlarged sebaceous follicles containing scales of epidermis, which form occasionally in the meatus. If their progress be unchecked, they are apt to destroy life by causing absorption of the bone and exciting disease in the brain.* They may exist and even prove fatal in early life, though they are most frequent in the old. They are attended in their later stages with discharge and pain. The treatment would consist in laying open the swelling, evacuating the accumulated laminæ of epidermis by the syringe, and then withdrawing by means of a forceps the thick membrane lining the tumour. But when they are chiefly situated within the tympanum, the diagnosis is difficult.

Exostoses sometimes form in the walls of the meatus; these may grow from either of its surfaces, and cases are not unfrequently seen in which two or more of such formations approach each other towards the mesian line. The hearing is by no means always impaired in proportion to the closure of the canal; but when the occlusion is complete, which I have twice seen, the deafness is considerable. Cerumen or epidermis may accumulate behind these growths, and will then require great patience, and a persevering use of fluids adapted to soften the mass, in order to effect its removal. This form of exostosis may occur in comparatively early life. Treatment is not so inefficacious as might have been feared. I have seen a severe case, in which the application of tincture of iodine seemed to induce a diminution of the tumours, and improvement of the hearing. Mr. Wilde speaks confidently of the power of local depletion, counter-irritation, and mercurials to arrest their progress in

* Mr. Toynbee first described this affection, see *Med.-Chir. Trans.* vol. xlv. p. 51, and *Diseases of the Ear*, 2nd edit. supplement. Dr. Von Troeltsch believes the tumours are merely accumulations of secretion and not distinct growths, but I have met with them as small firm white bodies surrounded by a distinct membrane in cases in which there was no evidence of any large amount of secretion. See *Path. Trans.* vol. xvi. p 233.

the early stage, when there probably exists a chronic state of periostitis.

III. AFFECTIONS OF THE MEMBRANA TYMPANI.

The membrana tympani is a thin colourless diaphragm, stretched obliquely across the inner extremity of the meatus. In its healthy state it is almost transparent; it reflects light strongly, and owing to its peculiar curvature, presents a bright spot of triangular shape at its lower and anterior portion. This spot becomes obscured or altered in disease. Although the membrane is freely permeated by blood-vessels, which become turgid in congestion or inflammation, and may give it a deep red colour, none, or only a few small ones, are visible in its normal condition. Its external surface is concave, with the exception of a narrow ring around its border. For practical purposes, the membrana tympani may be considered as consisting of three laminae—dermoid, fibrous, and mucous; each of which may present distinct morbid conditions. The only guide to these is of course examination by the speculum. Inflation of the tympanum through the Eustachian tube, may also be had recourse to; certain effects of the pressure of air on the internal surface of the membrane indicating tension, relaxation, rigidity, or ulceration of its layers.

In addition to the diseases which directly affect its own structure, the membrana tympani is often secondarily implicated in morbid conditions of more internal parts, and its appearance may give most important aid in their diagnosis. Thus in obstruction of the Eustachian tube the membrane is drawn inwards, its natural concavity being increased, and the polish of its surface diminished. Mucous or other accumulations within the tympanum may, on the other hand, cause it to bulge outwards; and the presence of an opaque fluid in that cavity may often be clearly recognised, through its transparent structure.

Injuries of the membrana tympani.—This membrane is liable to be ruptured from various causes, as the introduction of pointed instruments, a fall, or very loud sounds, such as the explosion of artillery, especially if occurring unexpectedly, so that the membrane has not been prepared for their reception by its adjusting muscles. A box on the ear, of which no warning has been given, will also produce the same effect, apparently by

membrana tympani receiving the necessary state of tension. Sportsmen are liable to this accident from the report of their guns. Undue force of syringing, violent blowing of the nose, vomiting, paroxysms of hooping-cough, also have caused rupture of the membrana tympani; but in these cases there is little doubt that the membrane was previously weakened by disease. It may give way in death by strangulation. The symptoms of rupture of this membrane are pain, generally not severe, felt at the bottom of the meatus, soon followed by the appearance of a few drops of blood. The hearing is not necessarily impaired. If an examination is made shortly after the accident, a small clot of blood may be seen closing the wound, which is generally from a line to a line and a half in extent. In the majority of cases it heals speedily, and without any further symptoms. The clot falls off in the course of a few days, but a white cicatrix is visible for a long time. Occasionally, however, ulceration is set up, or a small portion of the membrane seems to slough, the aperture increasing in size for some days. In all the cases I have seen, however, in which the rupture has occurred in a healthy membrane, perfect repair has finally ensued, and without injury to the function of the organ. In the treatment, it is for the most part only necessary to guard the natural process of repair from interruption. It may be advisable, however, if there be discharge, cautiously to cleanse the meatus by the syringe. A leech or two may be applied to the edge of the meatus if irritation be present and the orifice seem extending, or the edges of the wound may be lightly touched with nitrate of silver. Indeed, under this latter plan, small orifices in the membrana tympani, that have existed for some time, will sometimes heal.

Inflammation of the membrana tympani.—Frequently the epidermis covering the external surface of this membrane is thickened and opaque, no other morbid condition being present. This is of no importance pathologically, but it is a frequent cause of what is described merely as ‘opacity of the membrana tympani,’ which in itself is of course not a cause of deafness. Congestion of the membrane may arise from exposure to cold; it is attended with a feeling of slight uneasiness inside the ear, and sometimes with buzzing noises; and on examination, enlarged red vessels may be seen on the surface. Avoidance of

exposure, stimulating liniments, and warm oil dropped into the meatus, generally suffice for relief.

The *dermoid* lamina is subject to acute and chronic inflammation.

Acute inflammation is not common as an isolated affection, but it seems to occur sometimes from the application of cold or of irritating substances in debilitated constitutions. The symptoms are pain, not very severe, generally attended with tinnitus and some diminution of hearing. The surface of the membrana tympani becomes of a red colour, large and distended vessels being visible; it appears swollen also, and there is sometimes a secretion from it of viscid mucus. I have seen small abscesses form in this layer of the membrane and heal without permanent injury to the hearing. For the local treatment, one or two leeches may be applied to the orifice of the meatus; gentle syringing with warm water should be employed; and in the later stages mild astringents or a weak solution of the nitrate of silver may be had recourse to.

Chronic inflammation of the dermoid lamina may remain as an effect of the acute form; may arise from cold or other causes in weak or neglected children; may supervene in the course of, or after, the exanthemata; or may coexist with affections of the skin in other parts of the body; or with inflammation of the meatus. It occurs chiefly in the class of patients termed 'strumous,' and is said to have been observed to alternate with strumous ophthalmia. It is attended sometimes with a rather copious mucous discharge, at others with an excessive secretion of epidermis, which may accumulate in thick scales upon the surface of the membrana tympani, and give rise to deafness and great irritation. These scales may be removed by syringing, or, if difficult to dislodge, may be softened by the use of warm oil or water. The membrana tympani in some of these cases becomes greatly hypertrophied, and granulations of a bright-red colour, and easily bleeding, may form upon its surface. This affection is generally painless; but in the severer forms the hearing is always much impaired. In the treatment, cleanliness should be maintained by the syringe, and the greatest attention paid to the state of the health, which will almost invariably be found more or less deranged. In children, quinine, steel, and cod-liver oil are almost always useful. Sponging, friction of the skin, and other points of hygiene, require attention; and with these, local measures may be combined. Vesication

dropped into the meatus; or the membrane may be washed over with a solution of ten or twenty grains of the nitrate of silver to the ounce of water. But before having recourse to any topical applications, it is desirable to give cleanliness, combined with good general treatment, a fair trial. A considerable improvement seldom fails to ensue.

That inflammations of this layer of the *membrana tympani* are sometimes *specific* in their character, can hardly be doubted; but no distinctive marks of the presence of the syphilitic, or scrofulous, or gouty taint, have yet been pointed out in the diseased structures. The diagnosis must be determined by the history and the general condition of the patient. I believe also, that in all such cases the chief seat of the disease is in the deeper structures of the ear.

It often happens that after the removal of hard and adherent masses of epidermis from the meatus the membrane is seen to present a red and tumefied surface, generally at the upper part, from which no doubt the diseased epidermis is thrown off. The affection is of considerable importance, because though it readily subsides if the meatus is thoroughly cleared, and a solution of nitrate of silver applied, it may lead if neglected to the most serious consequences. An inflammatory swelling of the meatus may at any moment supervene, and extension of irritation inwards then becomes very difficult to prevent. I believe this condition may result from injudicious cleaning out of the ear.

The *fibrous* laminae of the membrane appear to be subject to affections connected with a rheumatic or gouty diathesis; but in an acute form these are rare, and probably are seldom dissociated from general affections of the tympanum.

In *chronic* inflammation, the fibrous laminae become thickened and hypertrophied, and the membrane presents a leaden appearance, often with congested vessels ramifying over its surface. The hearing is greatly impaired; which is less due, probably, to the condition of the *membrana tympani*, than to that of the lining of the tympanic cavity. The membrane may appear flattened, or if it retain its form and curvature, it is dense and rigid; and if the patient inflates the tympanum, while the surgeon keeps his eye fixed on the membrane by means of the speculum, the natural yielding to the stream of air is not perceived. Pain is seldom complained of, but there is fre-

quently a great amount of tinnitus. The treatment of both these affections is the same as for inflammation of the cavity of the tympanum. Mr. Toynbee recommends also the application to the surface of the membrane of a solution of the nitrate of silver (ten or twenty grains to the ounce), but the advantage of any such applications needs further proof. In the entirely chronic stage ether or sp. camph. ʒj. with liq. opii ʒss. in glyc. ʒj. may give relief to the tinnitus.

There is an opposite condition to which the membrana tympani is liable, and in which its fibrous layers seem to be chiefly concerned—that of *relaxation*. Patients come before us in whom the membrane has lost its natural regular form, and appears almost as if crumpled, sometimes falling in towards the promontory. In some of these cases the polish and translucency of the membrane are scarcely at all diminished; in others it is opaque and dull, in others red and swollen. This ‘relaxation’ sometimes coexists with inflammation, at others it seems to be connected with an ‘atrophy’ of the fibrous laminae, which cannot always be traced to previous inflammatory action; the scars resulting from previous loss of substance also generally appear as thinned and depressed spots. In some of these cases considerable deafness is present, which is relieved when the tympanum is inflated and the relaxed portions of the membrane put upon the stretch, but soon returns. For these cases—if the tympanum appears otherwise healthy—various astringent applications may be tried, and also the plan recommended by Politzer, of retaining the membrane in its place, after inflation, by closing the meatus air-tight by means of a plug of cotton-wool rolled in wax, and worn for several consecutive hours. In a large proportion of these cases also the artificial membrane, or a plug of cotton-wool moistened in glycerine containing sulphate of zinc (gr. x.—xx. ad. ʒj.), answers well—no doubt by maintaining the ossicula in better positions.

But in the vast majority of these cases the chief seat of the disease is more internal; often the Eustachian tube is narrowed though not necessarily occluded, or the results of old catarrh within the tympanum remain in the form of collections of viscid mucus, which demand evacuation by incision of the membrane. This is still more apt to be the case in the condition termed by Sir William Wilde, ‘collapse’ of the membrane, in which its natural structure and position are altogether lost, and it lies more or less unevenly in contact with the whole of

more or less distinct projections. In some of these cases a persevering treatment of the Eustachian tube, by bougies, &c., and the thorough evacuation of all morbid contents from the tympanum, will lead to a truly marvellous restoration of hearing, but the patient should be warned of the tediousness and probable painfulness of the treatment and, in bad cases, of the uncertainty of the result.

Ulceration of the fibrous laminae may occur, though not frequently, as a result of their continued inflammation. The dermoid layer of course partakes in the affection, and it is attended with a discharge from the meatus. It may either lead to perforation, or result merely in a thinning of the membrane, the mucous layer retaining its continuity. In the latter case the ulcerated surface appears depressed below the general plane of the membrane; it has an irregularly circular shape, and sometimes occupies a considerable extent. When the tympanum is inflated, the mucous membrane, lacking support, bulges at this spot, and may be distinctly seen to form a projecting sac. This condition seems not to be always accompanied with other disease, and is susceptible of benefit, especially if the ulceration be extending, by a weak solution of nitrate of silver cautiously applied to the surface; general treatment being at the same time adopted.

Calcareous deposits are frequently seen in the membrana tympani; they present chiefly two forms: either that of a small crescentic layer, evidently taking the course of the circular fibres; or that of an irregularly radiating mass, which has its seat amid the radiate fibres. These deposits are generally met with in cases of long-standing inflammatory disease, and then deafness is present; but they do not seem to be themselves any considerable impediments to hearing, since they are also seen in persons whose hearing power is scarcely diminished, and in whom the membrane itself appears to be in other respects in its normal state. Sometimes the degeneration affects the entire extent of the membrane, which is thus converted into a bony mass. But in these cases there is usually also extensive disease of the tympanum. These deposits consist chiefly of phosphate of lime. They are most frequent when the membrane is perforated, and a chronic inflammation of the tympanum has existed for a long time; but they are by no means confined to the later periods of life. In all these cases, any inflammation that exists may be combated by appropriate means.

In some of these cases *incision* of the membrane will give great relief, alike to the deafness and to the tinnitus if any be present, or if a simple incision be not sufficient, the *excision* of the diseased portion of the membrane—a proceeding first carried out by Dr. J. Gruber of Vienna—will often be very effectual. This last operation may be carried out by a simple knife, like a small and very thin-handled cataract knife, and a delicate pair of curved forceps. I have known not only the hearing greatly improved, but very distressing sensations of oppression in the head immediately relieved by it. The only drawback is that owing to the very strong tendency of the membrane to heal, the relief is generally but temporary. To obviate this Dr. Adam Politzer of Vienna has suggested the introduction into the incision of a small vulcanite ring, grooved so as to remain *in situ*, and with a silken thread attached to ensure its not falling into the tympanum. That this procedure is efficacious to a certain extent I have proved; but my experience does not enable me to say whether a *permanent* benefit can be secured. With due precautions I have not found it give rise to irritation.

The class of cases in which *incision of the membrane* is useful is difficult to define, and I confess that my own practice in this respect is as yet largely guided by theory. Where abnormal 'tension' appears to exist, it is reasonable to have recourse to it if other means fail, especially since it is very slightly painful and may be said to be wholly free from danger, either of exciting irritation or injuring the hearing. In some cases it appears to act favourably by diminishing such tension, as indicated by a wide gaping of the wound. In others there is no such appearance, the edges of the incision remaining simply in contact; and in some of the cases in which the greatest relief has been given the membrane has appeared to be flabby and soft, even in an extreme degree, cutting like a layer of soaked leather. But the very temporary nature of the benefit procured when incision is had recourse to except as a step to further procedure, greatly reduces its value.

Fabrizzi's instrument for excising a circular portion of the membrane does not appear to have any special advantage over a simple double-edged knife, by which a portion can be excised if desired, or a crucial incision made and the edges turned back. It has been proposed to obtain a permanent opening by inducing adhesion of the edges of a triangular flap of the membrane

meatus.

Dr. Wreden, of St. Petersburg, has introduced an instrument, combining a small revolving blade and a forceps, by which the whole or the greater part of the handle of the malleus can be removed, together with the adjacent membrane. There is no reason to doubt that great relief is thus afforded in some cases, but whether it is permanent or not, does not yet appear. The method that seems at present to me most deserving of further trial is the 'ring' suggested by Dr. Politzer.

Perforation: the artificial membrana tympani.—The membrana tympani may become perforated in two ways: either by disease affecting the membrane itself, and usually progressing from without inwards, by ulceration of its laminae, or much more frequently as the result of inflammation within the tympanum, causing accumulation of mucus or other morbid secretion within that cavity, which at length finds its way through the membrane into the meatus.

The diagnosis of perforation is generally easy. After the meatus has been cleaned out with warm water, the orifice may for the most part be very distinctly seen by the aid of the speculum. Or a peculiar pulsation (first described in this relation by Mr. Wilde) visible in the situation of the aperture, and probably due to the presence of a film or bubble of water, is very characteristic. If the Eustachian tube is not obstructed, the patient can blow air through the meatus with a prolonged whistling sound, which is perfectly diagnostic of the affection. If he cannot, it can generally be caused to pass by Politzer's method of inflation (see p. 287) or the Eustachian catheter. The aperture may be of any size, from less than that of a pin's head to almost the entire extent of the membrane. When the destruction of the membrane is considerable, the remaining portion usually presents a distinct lunated edge; and if the greater part is absent, the handle of the malleus, with a narrow strip of membrane on each side, is generally to be seen, either occupying its natural position, or fallen inwards. Sometimes this portion of bone remains with no membrane attached; sometimes the head of the malleus alone is left, and forms a prominent and characteristic object near the roof of the meatus. The border of the remaining portion of the membrane may be adherent to the promontory, forming a more or less completely

escaping, serious consequences may ensue.

Perforation of the membrana tympani produces, for the most part, a certain amount of deafness, though when the aperture is small and the ear otherwise healthy this is so slight as to be scarcely appreciable. In recent cases the closure of the orifice, if small, is always to be sought; the occasional application of a solution of nitrate of silver (ʒj.—5j. ad. ʒj.) to the edges of the wound, and the subjugation of inflammatory action by appropriate means, will generally secure this result. In fact, the extent to which loss of the substance of the membrane may be restored, in the course of time, is very remarkable. I have now under my observation a child of twelve, in whom four years ago nothing of the membrane existed beyond a scarcely visible margin; the whole of the anterior and lower portions are now replaced by a distinct transparent layer, which the eye could not distinguish from the natural membrane, and which is thin inferiorly, and somewhat whiter and thicker anteriorly. There is every reason to believe that the restorative process in this case is not yet complete. It was treated by me by means of talc, as described hereafter. But almost always when the membrana tympani is perforated there exists a state of chronic irritation of the lining membrane of the tympanum, attended with either a constant or an intermittent discharge. On examination a foetid mass of inspissated discharge will generally be found in the meatus, itself sufficient to set up inflammation; and on syringing this away the mucous membrane of the tympanum will be seen red, swollen, and velvety; often so thickened as to project almost to a level with the orifice in the membrane. In the treatment the chief point is to secure the perfect removal of the morbid secretion, which is apt to be extremely viscid, from all the recesses of the tympanum and Eustachian tube. In my opinion the difficulty of ensuring this is the sole cause of the proverbial tediousness and unsatisfactoriness of these cases. And, fortunately, the very existence of the perforation puts it in our power completely to evacuate the tympanum, by passing fluids, from the meatus inwards through the Eustachian tube. Above, and almost even in the place of, all other things, the treatment of chronic perforations of the membrana tympani should consist in first washing out the cavity by means of alkaline solutions passed from the meatus through the Eustachian tube into the fauces. This is not painful unless irritation

is closed, which then should be first rendered patent. It is very simply done, and the only ill effect I have known ensue is a temporary giddiness, lasting a minute or two. This giddiness is, of course, much greater when the water used is too cool or too warm, but it will sometimes occur without any error of temperature. It affords no reason for modifying the treatment. An ordinary syringe suffices, a piece of india-rubber being placed upon the nozzle, so as nearly to close the meatus. When the surgeon has proof that the membrane is really perforated, and that the Eustachian tube is pervious, very considerable force, if it is necessary, may be safely used; and the stream will often bring away enormous and almost incredible masses of more or less altered and inspissated secretion, with manifest improvement. The proceeding should be repeated as often as seems necessary, even for many weeks in some cases. I have known semi-solid masses of old offensive secretion to come away from a tympanum which had been thus treated, even after a stream of fluid had been several times passed through the ear without removing anything more than a few flakes of recent mucus; and my conviction is that in some, both of these cases and of those in which I am in the habit of incising the membrane with the view of thus washing out the tympanum, the mastoid cells and other recesses of the cavity gradually empty themselves beneath the influence of the stream; and that masses of half-dried mucus which have been accumulating for years may be thus dissolved and washed away. I believe that experience of the method could not fail at once to convince and to astonish every one who tried it. I use first alkalies—soda, or carbonate and chlorate of potash—in nearly saturated solutions, and afterwards employ for the most part alum or sulphate of zinc (gr. iv.—x. ad. 3j.)

At the same time, if granulations are present, I apply caustics; generally either a strong solution of nitrate of silver, or, if a powerful action is required, chloroacetic acid; but chloride of zinc, also, is very effective—either may be applied by a camel's-hair brush.

Dr. Schwartze, of Halle, has strongly recommended, for the treatment of perforations when no granulations are present, solutions of nitrate of silver (from two to forty grains to the ounce). These he pours into the ear, and then, by means of a glass tube, made to fit the meatus by india-rubber, blows them through the Eustachian tube so as to reach the fauces. Imme-

common salt, causing it to pass as far inwards as the caustic has done. The insoluble chloride of silver is formed, and comes away in large flakes. Excellent results, no doubt, are thus attained, but it is necessary to use caution, as the pain caused by too strong a solution is very severe. I should always postpone its use until after the ear had been repeatedly syringed *through*, as described above, with an alkali, and some mild astringent. Dr. Schwartze recommends it to be repeated daily for a few times, the discharge soon ceasing under its use in his hands. Another method of bringing about a permanent cessation of discharge when granulations are removed, or even before, is to employ talc (French chalk) in powder. All discharge being removed by syringing—for which purpose the patient should blow through the ear while the syringe is used—the surface should be thoroughly dried, as far as possible (lint rolled up, or the fringe of a towel, answer well). A little of the powdered talc should then be taken up in a small glass tube and blown into the meatus by a sharp puff. An elastic bag is preferable to the mouth. This should be repeated, if necessary, until the bottom of the meatus is well covered. The process should be repeated daily, and it is seldom that many applications are necessary; but the ear should be, each time, well cleansed and dried. I know no more effective plan than this, but it is somewhat tedious, and requires daily attendance, and is, therefore, naturally reserved for the more obstinate cases.

Of lotions I have found the perchloride of mercury the best as a general rule: a third of a grain to the ounce is almost always well borne; if stronger it is apt to be irritating. With it, as with every lotion, I combine opium or morphia, giving the preference to the tincture, from two to thirty drops. Of proper astringent lotions the sulphate of zinc (gr. ij.—x. ad. ʒj.) stands first; next to it the liq. ferri perchlor. (℥ x. ad. ʒj.); and then tannin (gr. x. ad. ʒj.). Whatever lotion is used, the patient should fill the ear, force air through the Eustachian tube freely, and let it run out, repeating this two or three times morning and evening. Syringing for himself is seldom useful, unless the patient can see the surgeon only at long intervals. The liquor plumbi is seldom advisable as a lotion in perforations, though it is often useful in granular conditions without rupture, and is very useful applied undiluted to granulations, or the roots of polypi growing from the edges of an orifice or the tympanic wall.

It sometimes happens that an orifice in the membrane is of

In this case the irritation continues in spite of treatment, and the membrane often assumes a red, and, in parts, granular aspect, and appears irregularly swollen. When air is forced into the tympanum it will sometimes escape through a minute orifice, bringing with it bubbles of air and mucus; at others, though it enters the drum, it does not pass through the membrane until a little viscid mass has been first protruded. I have in some cases clearly seen two such minute orifices. The treatment I employ, after a due trial of other means, is to enlarge the outlet by incision.

The most tedious perforations that I have met with are those which are situated at the anterior and lower part of the membrane, very near to the wall of the meatus. I believe the reason is that the perfect emptying of the tympanum is more difficult owing to the orifice being nearly in a line with the Eustachian tube; so that the posterior part of the tympanum remains very much a closed cavity.

The artificial membrana tympani.—To however great an extent the membrana tympani may be destroyed the hearing may suffer comparatively little, and with the treatment above described, it often happens that not only the discharge ceases and the exposed surface assumes a healthy aspect, but the hearing recovers sufficiently for all the patient's needs. Should this not be the case it is probable that there exists some relaxation of the connections of the ossicula. In such conditions astringent solutions, as sulphate of zinc, often produce great temporary improvement, but the remedy is some form of artificial membrane—either the moistened cotton-wool of Mr. Yearsly, or the india-rubber disc or globe proposed by Mr. Toynbee. Each form has its special advantages, and a case that seems to demand it should not be abandoned till all have been tried. For the cotton-wool I prefer glycerine to water, as it then will retain sufficient moisture not to need changing for four or five days; and in most cases I add to the ounce of glycerine from five to twenty grains of sulphate of zinc. Being rolled up into a small spindle-shaped plug, about half an inch long, it may be introduced either by a pair of forceps, or threaded through a narrow silver tube.* I think it is best to

* Prepared cotton, &c., as also all the other forms of artificial membrane, are sold by Messrs. Weiss, of the Strand.

direct whatever form of artificial membrane is used towards the upper and posterior part of the tympanum, so as to touch, if it be present, the head of the stapes. A little pain is sometimes complained of, but if the attempt succeeds well the patient is immediately conscious of hearing better, and the cotton or disc should then be left *in situ*, and the tube or forceps carefully withdrawn. After a little instruction from the surgeon the patient soon learns to apply it himself, and if care is taken to prevent accumulation of discharge or epidermis, the effect continues indefinitely, and often becomes, even in cases of otherwise extreme deafness, so permanent as to render possible the discontinuance of the membrane. If the india-rubber disc is used, one made with a thread attached, and introduced by means of a tube, is preferable to one fixed upon a wire. Mr. Toynbee says:—

‘After accurately noting the size of the inner extremity of the meatus to which the natural membrane was attached, the operator should proceed to cut the artificial membrane as nearly of the size and shape of the natural one as possible, taking care at the same time to keep the margin quite smooth and regular. The patient should then be placed with the head inclined to the opposite shoulder, while a strong light is thrown into the meatus, which, if liable to discharge, should have been previously syringed. The operator will next take the artificial membrane, and having moistened it with warm water, pass it, by means of the silver wire, gently inwards, until it has reached what he considers the natural position. This he will ascertain by the occurrence of a faint bubbling sound caused by the escape of the slightly compressed air beyond it: he will also feel a slight obstruction offered to its further passage by the remnant of the natural membrane. Should any attempt be made to pass the artificial membrane beyond this point, the patient will complain of pain, which up till then had not been felt. The most certain test, however, of the proper placing of the artificial membrane is the sensation of the patient, who discovers by the sound of his own voice, or that of the surgeon, or by the movement of his tongue and lips, that his hearing has been suddenly improved.’

It is advisable, when there remains only a very narrow ring of the natural membrane, to cut the artificial one a little larger, so that its edges may turn slightly backwards when it is introduced. I have, however, sometimes found that a portion of membrane cut to the shape of the aperture, but a little larger in size, and applied directly to the ruptured spot, has answered better than when the whole surface has been covered. At first the artificial membrane should be worn only for an hour or two, or even a shorter time, daily, and should be discontinued for a time if any irritation arise. It should be removed at night.

Polypi.—These growths may, for practical purposes, be

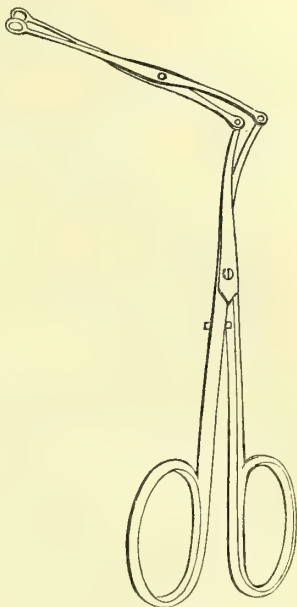
their structure, and the corresponding difficulty of eradicating them; some of the more dense of the latter also bleeding very considerably when removed. But minute examination reveals considerable complexity of structure in some of these formations, and there is an accumulating body of evidence that their structure varies definitely according to the surface from which they spring, and that those which arise from the meatus, or from the walls of the tympanum, possess a corresponding glandular structure which is wanting in those which spring from the outer surface of the membrana tympani. Their most frequent seat, in my experience, is the inner wall of the tympanum, the membrane being ruptured; but it is important to remember that they may form within the tympanum without the existence of any perforation. In this case they may either cause the membrane to give way, and literally grow through it, or at least appear to do so, or they may remain within the cavity, giving rise to great irritation, and require treatment by incision. In one such case (see *Clinical Society's Transactions*, vol. ii.) a polypus nearly as large as a pea was evacuated, with entire relief, having apparently become detached, and acting as a foreign body. Twice in post mortem examinations I have found small polypi growing from the *inner* surface of the membrana tympani. Next to the exposed tympanic wall the most frequent seat of polypi is the inner part of the meatus, and then the external surface of the membrane. Whatever their seat and nature they require essentially the same treatment, viz. the soothing of any irritation; the removal, as far as practicable, of all accumulated discharge; the eradication of the growth, and restoration to a perfectly healthy state, of the surface from which it sprang. For the first purpose, if any means are necessary, leeches, a few small blisters, and lotions of diluted liq. plumbi are the best; the second may be effected by syringing with alkaline solutions, forcing them through the tympanum if a perforation exists, and by the nose douche, or the patient drawing or syringing through the nostrils a solution of soda (gr. x. ad. ℥j.). For the removal of the polypus, if it be of any size, I prefer Sir W. Wilde's snare, armed not with wire, but with the gimp used by anglers. This is much less fragile, and less painful. The polypus may generally be thus cut through close to its root. When too small to be grasped by the snare, Mr. Toynbee's 'lever ring forceps,' consisting of two small rings

closed by a movable cannula, or that here depicted, are both very efficient. After a polypus of long standing has been removed it frequently happens that large masses of old, half-dried, offensive discharge are exposed, and may be removed by the syringe, or the surface is found covered with dense layers of epidermis requiring a prolonged use of alkaline lotions to soften them. When this is the case the removal of the growth often gives relief to very distressing symptoms.

But after this has been done the real treatment of the case commences: for, as the rule, no sooner is a polypus removed than it begins at once to reproduce itself, and the only means that can be relied upon to prevent this are to apply caustics, and afterwards other astringent or drying substances, *keeping the tympanum sedulously free from collections of discharge*, until a perfectly healthy state of the surface is induced. With-

out carrying this process thoroughly to a conclusion, to remove a polypus, unless for temporary relief, is to inflict useless pain. Liq. plumbi, applied by a camel's-hair brush daily for a few days before the caustic, greatly diminishes the pain. Chloroacetic acid, potassa fusa, carefully guarded, chromic acid, or chloride of zinc, are good caustics. Nitrate of silver is excellent in the later stages. The caustic is best applied daily until a decided effect is produced, this being by far the least painful and tedious mode of using it. At the same time, a lotion of perchloride of mercury (gr. $\frac{1}{3}$ ad. ℥j.) with tinct. opii $\text{m}\text{v.}$ —x. should be used twice a day; the Eustachian tube, if closed, should be made pervious; and if the membrane be perforated, a syringing from the meatus through the nostril practised frequently, as above described, unless it be contra-indicated. When the root of the polypus shows manifest signs of disappearing we can often substitute for the caustic the undiluted liq. plumbi, or the powdered talc. By these means polypi of the largest size and most obstinate character may, so far as my recent experience extends,

FIG. 148.



Forceps for extracting small Polypi.

always be entirely eradicated, and the tendency to their reproduction destroyed; or, if there be any exception, it is in some rare cases of the densest and most vascular form of fibrous polypus, in which the use of caustic results in a drying up rather than a total removal of the mass. The time occupied in the entire procedure varies from three weeks to three or four months. It is desirable not to commence it except with a thorough understanding on the patient's part of its tediousness, and unless completed, its uselessness; but I have not known any one who persevered regret the trouble. The surgeon should remember that these growths are very often, probably most often, multiple, and this from the very commencement. I have syringed from a child's ear four distinct minute polypi, each one evidently a separate growth.

Instead of removal, injection into the substance of the polypus of a few drops of liq. ferri perchloridi has been practised with success, but I have not sufficient experience to speak positively of its results. Before removal the soft and sensitive texture may be deadened by a few applications of liq. plumbi in which morphia has been dissolved; and I have sometimes caused sloughing of one of the softer kind, when removal was refused, by pressing into its substance a fragment of nitrate of silver. But the pain of treatment by caustics, of course, greatly exceeds that of the snare.

Granulations on the surface of the membrana tympani are not uncommon, either with or without perforation. Their treatment is essentially that of the root of a polypus, but their presence almost certainly indicates disease within the tympanum, the treatment of which is of the chief moment. Very frequently the membrane demands incision.

IV. AFFECTIONS OF THE EUSTACHIAN TUBE.

The ordinary condition of the Eustachian tube, as shown by Mr. Toynbee, appears to be that of closure by the apposition of its walls. It is opened by the tensor palati during the act of swallowing, and probably at all times, when in a healthy state, permits the gradual escape from the tympanum of fluids as well as of air. That it is not permanently open is shown by the effect of inflating the tympanum with closed mouth and nostrils, the feeling of distension within the ear produced by which only gradually subsides unless the act of swallowing be performed,

when it disappears at once. If this experiment be made by a healthy person while the surgeon keeps his eye fixed upon the *membrana tympani*, that membrane may be seen to yield slightly to the pressure of the air, assuming a less concave position, which is retained for a time, even while the natural respiration is carried on. If the act of swallowing be now performed, the membrane may be seen to fall back at once to its normal position. Similar effects are said to be experienced during a descent in a diving-bell. In addition to these facts, certain symptoms which attend *an open condition of the Eustachian tube*, first described by Dr. Jago, of Truro, give evidence in the same direction. This affection is attended with a buzzing noise, and an unnaturally vivid hearing of all sounds which have their origin in the patient's own mouth, throat, or stomach, to such an extent as greatly to interfere with the hearing of external sounds. There is at the same time a feeling of discomfort in the throat, which the patient endeavours to relieve by repeated acts of swallowing. The cause of this condition appears to be some state of the throat, but of what character is not clear; perhaps some irritation keeping the muscles attached to the Eustachian tube in a state of spasmodic action. The symptoms occur most frequently during catarrhal affections. For the most part they are intermittent, the restoration of the natural apposition of the walls of the tube removing them at once.*

Much more frequent and more serious is the opposite affection, *obstruction of the Eustachian tube*. This condition may be due to various causes; thickening of the mucous membrane of the fauces or tympanum, or relaxation of the fauces, appear to be the most frequent. Stricture of the osseous walls of the tubes occurs sometimes, though rarely; firm membranous adhesions are occasionally found completely closing it, and accumulations

* It has been recently shown by Dr. Rüdinger of Munich that the Eustachian tube consists of two portions, the narrow and slit-like tube being seen, on section, to terminate above in a kind of hook;—i.e. a small circular canal runs along the superior border of the flat one. It has been argued that this is always open, but the question seems not practically important, the interchange of air by means of it being at least very slow. That there is a muscle which closes as well as one which opens the Eustachian tube is indicated by many phenomena of disease; perhaps especially by the effects of local irritants which tightly close it. Sulphate of zinc *e.g.* syringed along it makes it for a time quite impervious. Dr. Von Troeltsch (*Archiv. für Ohrenheilkunde*, vol. i. p. 15) has argued from anatomy that the tensor palati alone opens the tube, the levator serving to close it.

of mucus no doubt have a similar effect. It is questionable whether enlargement of the tonsils can cause obstruction of the tubes. In reference, therefore, to the question of the removal of these glands in cases of deafness dependent on the condition of the throat, there seems to be no reason for departing from the rule that if their removal is desirable on general grounds, that is, if they are interfering with respiration and injuring the health, they should be excised, and not otherwise; unless, perhaps, in cases in which other means have failed, when the chance of benefit to the hearing may be weighed against that of injury to the patient from their loss. The slight loss of blood attending their excision may perhaps have a beneficial influence.

The diagnosis of obstruction of the Eustachian tube may be made by inspection of the membrana tympani, and by the use of the otoscope. This instrument is a flexible tube, one end of which is to be inserted into the ear of the surgeon, and the other into that of the patient, while the latter, closing the mouth and nostrils, either makes a forcible expiration or performs the act of swallowing. If the Eustachian tube be pervious, the air will almost always be heard (after some practice) to pass into the ear during one or other of these operations. The sound that results when the organ is in its normal state is a peculiar *thud*, somewhat like the striking of a bullet against a target heard at a great distance, or like the blowing suddenly into a small bag of silver paper. When disease is present this sound may be variously modified; a creaking or whistling may be heard if the Eustachian tube be narrowed by thickening of its lining membrane; a 'gurgling' indicates the presence of mucus or other fluid within the tube or tympanum. It is seldom the case that if the Eustachian tube be pervious no sound is audible, when the patient has learnt rightly to make the experiment; and if neither any sound can be heard nor any movement of the membrana tympani seen during the actions above described, and the other symptoms agree, obstruction of the tube may be confidently inferred. But the appearance of the membrana tympani also, in these cases, is very characteristic. Whether it be due to absorption of the air within the tympanum, when it is not freely renewed, or to any other cause, the membrana tympani always, when the Eustachian tube is permanently closed, becomes more concave than natural, as if drawn or pressed in towards the cavity of the tympanum. It becomes at

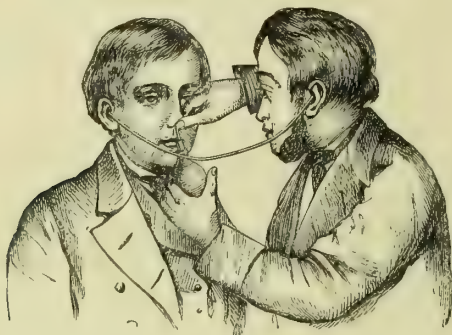
the same time of a dull colour, and frequently somewhat opaque, the bright spot on its surface being indistinct and diffused. This condition of the membrane may be distinguished from the results of inflammation by the more decided concavity, without irregularity, and the absence of congestion or thickening.

The history also is characteristic of the disease. The deafness has for the most part arisen gradually, without any considerable amount of pain, and after repeated attacks of cold or sore throat. Often the hearing will have been suddenly restored at various periods after a loud crack or report in the ear, and gradually lost again.

Obstruction of the Eustachian tube from thickening of the mucous membrane of the fauces.—This affection is more frequent before than after middle age (the deafness of advancing years being more connected with morbid conditions of the tympanum); and it is especially common in scrofulous or otherwise unhealthy children. The appearance of these latter patients very often at once betrays the nature of the malady; there is a fulness about the back part of the jaw, and, especially when the tonsils are also enlarged, they have a peculiar expression of countenance, arising from the mouth being kept slightly open to aid in respiration. They are also apt to snore when asleep. The deafness in these cases is considerable, the patient requiring to be spoken to in a distinct voice within a yard or two. A ‘stuffing’ in the ears, and more or less tinnitus, are generally complained of. The mucous membrane of the fauces is generally red and tumid. The treatment indicated is to restore the health, to remove collections of mucus in the fauces, and to reduce the thickened membrane. But besides these means it is desirable with very few, if any, exceptions, to take advantage of a proceeding beautiful for its simplicity and invaluable for its results, introduced by Dr. Adam Politzer, of Vienna, as a means of opening a closed Eustachian tube without having recourse to the catheter. Taking advantage of the natural opening of the tube during the act of swallowing, Dr. Politzer suggested that air should be forcibly blown into the upper part of the pharynx by the surgeon, while the patient swallows with closed mouth and nose. This is very easily effected, either by means of an india-rubber bag, or by a tube through which the surgeon may blow. First directing the patient to take a little water in the mouth, and to swallow it with closed mouth at a given signal, the

surgeon next introduces into one of his nostrils the nozzle of the elastic bag (best ending in a piece of elastic tube), and at the same time that the patient swallows he forces the air powerfully into the nose. Unless the obstruction be very great the air is almost sure to pass freely up the tube, and if the surgeon uses an otoscope (a simple piece of elastic tubing eighteen inches long is the best) he will hear it enter the tympanum. A

FIG. 149.



Politzer's method of opening the Eustachian tube.

loud clapping sound is sometimes heard, and is almost a certain indication of a restoration of the hearing; at other times the sounds are obscure or decidedly *moist*, indicating fluid within the tympanum, and the effect is slighter, or null. These cases belong to disease of the tympanum. If on the other hand the only or chief abnormal condition has been the closure of the tube the effect is most striking, and to the patient often most startling. In confirmed cases it is desirable to repeat this proceeding more or less frequently, and it often suffices, combined with general treatment; and especially with the use of a solution of soda or common salt, drawn or syringed through the nostrils, as before described. For bracing up the thickened membrane, I prefer to nitrate of silver, &c., dried alum powdered and blown into the angle behind the tonsil through a curved glass tube. An adult can quite easily draw in the powder for himself, by *sucking* through the tube. The alkaline solution through the nostril, combined with the powdered alum thus applied, is a very efficient plan of treatment. Sometimes, but rarely, a leech or two applied beneath the ears, or, by means of a tube, to the nasal mucous membrane on the affected side, or in both these situations at once, are desirable

at the commencement of the treatment. Stimulating and astringent gargles or inhalations may also be used if necessary. Frictions around the throat, either with salt and water or with stimulating liniments which may contain salts of iodine, will of course be recommended, together with ample exercise in the open air, and cold or tepid sponging. Tonics are often indicated, especially in children; the acid mixture of iron and sulphate of magnesia is the form that I prefer. The Eustachian tube may also be obstructed by thickening of the membrane lining its tympanic orifice, as a result of chronic inflammation within the tympanum.

Relaxation of the mucous membrane of the fauces will also produce closure of the Eustachian tubes. This condition is different from that of thickening, and occurs in a different class of patients. It is met with only in adults; chiefly in persons in weak health, and suffering under general relaxation of the system. Those who smoke to excess are especially liable to deafness from this cause. The lining membrane of the throat is pale and mottled, the uvula is elongated. The membrana tympani presents the characteristic dull and concave appearance. General bracing and tonic measures, with stimulating and astringent applications to the fauces and the orifices of the tubes, and the abandonment of any practices injurious to health, will effect a cure.

The Eustachian tube may also be obstructed by stricture of its bony walls. Two cases are reported by Mr. Toynbee. The same effect may be produced by effusion of fibrine uniting its surfaces by firmly organised tissue. In such cases as these the chief point would be to make an accurate diagnosis, and to avoid subjecting the patient to useless treatment. The exploration of the canal by an elastic sound would of course be necessary.

Among the rarer causes of obstruction of these tubes may be mentioned, on the authority of Sir W. Wilde, foreign bodies; 'the most remarkable case on record is that in which an ear of barley was discovered after death projecting from its guttural orifice.' The same author also mentions that he has seen deafness induced by a large fleshy nasal polypus, which passed down into the pharynx.

In cases in which the obstruction of the Eustachian tube will not yield to the means prescribed, recourse must be had to the *Eustachian catheter*, the use of which is happily, as a rule, free

alike from pain and danger. The patient being placed in an easy postura, the surgeon, standing on his right side, should take the catheter lightly between his finger and thumb and pass it gently along the floor of the nostril until it reaches the pharynx. At this point either of two methods may be adopted for conveying it to the opening of the tube. It may be carried on, its point still turned downwards, until it reaches the posterior wall of the pharynx, and then it may be drawn forwards about half an inch, being gently rotated at the same time outwards and upwards. In doing this it will for the most part easily slip into the trumpet-shaped orifice of the tube, and may be felt to be embraced by its walls. Or when the point of the catheter has arrived at the posterior nares, the instrument may be gently rotated outwards and slightly upwards, and carried on into the pharynx. In this way it may be passed directly into the Eustachian tube. The former plan, however, is the easier; and in the latter it is necessary to guard against entangling the point of the catheter in a lacuna which lies directly in its route. No bleeding should follow its use, unless there has been unusual resistance. Air may now be passed into the tympanum, either by an elastic bag or by means of a flexible tube, provided at one end with a mouthpiece, at the other with a small pipe fitting into the end of the catheter. The otoscope being placed, one end in the ear of the surgeon, and the other in that of the patient, the air, if it can be forced through the Eustachian tube, may be heard to pass into the tympanum and strike on the membrana tympani. The chief sources of failure in passing the Eustachian catheter are two: first, suffering the point of the instrument to slip up into the *middle* meatus, instead of sliding along the *floor of the lower*; and secondly, not drawing it far enough forward again after touching the posterior wall of the pharynx. In other words, if the instrument is wrongly placed, its point will generally be either too high up or too far in. Sometimes it happens that it slips some distance *down* the pharynx before being stopped by contact with its posterior wall, and in this case requires more than the average withdrawing; the distance between the orifice of the tube and the back of the pharynx is perceptibly greater in men than in women. Besides its use in closure of the tube, the catheter is constantly in requisition for the efficient diagnosis and treatment of disease within the tympanum, and facility in its application (which is not difficult) is indispensable to any

who wish to be able really to relieve this class of affections. A very little practice on the recent section of a skull gives all the skill that is needed. The best form of catheter, I believe, is that constructed of vulcanite ; various sizes and curves are desirable—the latter ranging from a very slight bend of the point to nearly a semicircle of an inch in diameter, for using through the opposite nostril in case that on the affected side should be impervious.

The only proofs that the catheter lies fairly in the tube, are hearing the air pass along the tube, or introducing a bougie, or observing its position by means of rhinoscopy. The latter, however, is seldom required, although an examination of the posterior nares and orifice of the tube by means of the mirror has added, and will no doubt add more, to our knowledge. It has exhibited, for example, ulcers of the mouth of the tube and incrustations of thick mucus over it, necrosed conditions of the adjacent bone, and complete obliteration of the orifice.

If air cannot be passed into the tympanum by means of the catheter, the tube may be opened by bougies. This proceeding is attended with a certain amount of pain, but with due caution it is free from serious danger, and by means of it very many otherwise incurable cases of deafness may be perfectly relieved. It is remarkable, indeed, how dense, and how confirmed strictures of the tube may by perseverance be thus thoroughly and permanently overcome. Often, indeed, one, or at most three or four, introductions of a thin and very elastic bougie will suffice ; but in other cases I have known a perseverance in their use, extending over many months, completely successful at last, and hearing restored with almost absolute perfection, where it had been absent for twenty years. In this case there existed also a collection of mucus within the tympanum, for which the membrane had been incised more than once, with only temporary benefit. When a stricture of great density exists, it is requisite to have recourse, very carefully, to whalebone bougies, and to laminaria, which may be suffered to remain in the tube five or ten minutes, the catheter and bougie being then withdrawn together. Two cases of laminaria bougies *breaking off* in the tube, are recorded by a German physician, but the fragments soon came away, leaving no ill effects. I have never found such an accident in the least degree threatened. But even in spite of care, slight abrasion of the mucous membrane will sometimes occur, and then if air be forcibly injected it becomes extravasated

in the cellular tissue, and causes a swelling which naturally alarms the patient. With the least prudence, however, this accident is never formidable. The air is entirely absorbed in a day or two, and after a fortnight's rest, the treatment may be quite safely proceeded with.* An excellent addition to the use of bougies is to introduce through the ordinary catheter another very small elastic one (capable of entering the tympanum through a normal tube) as far as it can be passed, and then to syringe through it, with moderate force, a strong alkaline, or weak caustic solution—using as it were hydraulic pressure. The inflation by Politzer's bag should be used concurrently; and by degrees a stricture that at first seemed hopeless will yield. When air has at length reached the tympanum, a few drops of a solution of nitrate of silver (gr. ij.—vj. ad. ℥j.) should be carefully syringed into it, and this may be repeated at intervals of two or three days if necessary, and if no severe pain ensues. The tube after a time remains pervious. In bad cases a daily introduction of the bougie is required; but it is needless to say that—unless in exceptional cases—neither this nor any other severe or prolonged treatment to the tympanum should be carried out unless the symptoms indicate that the nervous function is tolerably well maintained.

In syphilitic affections of the throat the Eustachian tube will sometimes become obstructed, but apparently much less frequently than might have been expected. Such cases seem to do perfectly well under a rational combination of the general and the local treatment.

V. AFFECTIONS OF THE TYMPANUM AND MASTOID CELLS.

During the last few years considerable light has been thrown upon some of the affections of the tympanum. Among other points the diagnosis between deafness depending upon tympanic or nerve lesions has been greatly advanced. The chief means of distinction is the tuning-fork, used in certain ways; the only drawback to its value being the fact that a certain

* It is my impression that a case of death after using the air-press, which made a great sensation in London some thirty years ago, and helped to throw Eustachian catheterism into very undeserved ill-repute, was due to extravasated air obstructing the larynx; but this cannot be made certain, and the evidence proves that the air was injected in a most rash and violent way, and apparently was entrusted to hands quite unskilled.

number of persons, otherwise of good hearing, are unable, or almost so, to hear it when placed upon the head. Allowing for this circumstance, which is not often of consequence, the following propositions may be laid down :

1. That in a normal state a tuning-fork is heard before the meatus after it has ceased to be heard on the vertex.

2. That when placed on the vertex, it is heard more plainly when the external meatus is closed.

3. Consequently when one meatus alone is closed, the tuning-fork is heard most plainly in the closed ear.

The reason of this fact appears to be, that the sound escapes freely through the tympanum and meatus, and that when its passage is impeded the waves are reflected and affect the labyrinth more strongly. Consequently in cases of disease the following inferences seem justified :

1. In cases of one-sided deafness, if the tuning-fork, when placed on the vertex, is heard most plainly in the deaf, or more deaf ear, the cause is seated in the conducting apparatus ; if it is heard loudest in the better ear, the cause is probably in some part of the nervous apparatus.

2. If, on closing the meatus, the tuning-fork is heard decidedly louder, there is no considerable impediment to the passage of sound through the tympanum.

3. If the tuning-fork is heard longer on the vertex than when placed close before the meatus, the cause of the deafness is in the conducting media.

4. However imperfectly the tuning-fork may be heard when placed on the vertex, it gives reason for suspecting only, and is not proof of, a nerve-affection.

Other conclusions also may be drawn from the use of the tuning-fork, but they are either corollaries of the foregoing, or are too doubtful to be of real value in practice ; but those mentioned are of the greatest and most constant practical value. With few exceptions they enable us at once to distinguish between an affection of the receptive and of the conducting portions of the organ ; and thus relieve us entirely from that which has been the great difficulty and discouragement in the treatment of diseases of the ear. I find it a good routine plan of examination to note in respect to the hearing, (1) the distance by the watch ; (2) whether watch heard on head ; (3) how long the tuning-fork is heard on the vertex—whether equal or not to some average standard, the surgeon's own

hearing of it, for example; (4) whether the sound is heard alike on both sides, or on which side it is louder; (5) the effect of closing each meatus; (6) whether it is louder on the vertex or before the meatus. If the deafness is considerable, and the tuning-fork indicates a normal condition of the tympanum, as *e.g.* that it is heard longer before the meatus than on the vertex, that its sound when on the vertex is increased by closing the meatus, and that it is heard best on the *least* affected side, I infer a 'nerve' affection. I have not found that the age of the patient materially affects these conclusions. Of course when thus assigned to the nervous system, the real nature of the affection remains altogether to be investigated, and it may in many cases have its real seat in parts altogether distinct from the ear, or in the tympanum itself, the impaired function of the nerve being entirely secondary.

The chief diseases to which the tympanum is liable are inflammation either of its mucous membrane or osseous walls, and the results of such inflammation, in the form of effusions or adhesions; rigidity of its lining membrane; deposits within its cavity or that of the mastoid cells; ankylosis either of the ossicula to each other or of the base of the stapes to the fenestra ovalis; and disconnection of the ossicula from each other, with or without caries.

Acute inflammation of the mucous membrane of the tympanum.
—This affection may exist in very various forms, from that of a slight degree of pain in the ear and deafness, rapidly subsiding, to that of a most severe and dangerous disease. It may occur in apparently healthy persons, and is then generally attributed to cold; it often accompanies an attack of catarrh. The mildest forms, which might perhaps be distinguished under the name of congestion, are characterised by an aching pain felt deeply within the ear, and for the most part by noises of a buzzing character; the hearing is impaired, but less in first than in subsequent attacks. The membrana tympani may be found on inspection slightly vascular, and either retaining its transparency, or dull; the meatus is healthy. Inflammation of the tympanum is rather painful; the air enters naturally, or with a slight creaking sound. This affection becomes of serious consequence by recurrence; for though the attacks may soon subside, a repetition of them seems to be a frequent cause of confirmed deafness, probably by producing thickening and rigidity of the delicate mucous lining of the tympanum. The

object to be aimed at in the treatment, is to subdue entirely the immediate symptoms, and to guard against a recurrence of the attacks. The former of these objects may be attained by simple antiphlogistic treatment: a leech or two below the meatus, a stimulating liniment, or a small portion of blistering-paper worn nightly on the mastoid process for a short time. Two or three drops of warm oil may be poured into the meatus night and morning. Habitual cold sponging and friction, especially around the ears, should be recommended to patients liable to this affection; and care should be taken to keep the throat in a healthy state. It is desirable to pay especial attention to preventive measures in all these cases, since they present to us one of the most common and most baffling forms of deafness in the very process of its formation. It would probably be a useful plan, if such patients inflated the tympanum with warm vapour every evening for some days after an attack; and neither patient nor surgeon should be content unless the full normal hearing power be regained. It is very seldom that persons suffering under deafness care to continue treatment until hearing is complete, since a certain imperfection occasions no inconvenience; but such cases as these might well form an exception to the rule.

A certain proportion of these cases no doubt result in the accumulation of mucus within the tympanum, as referred to hereafter.

The severer forms of acute inflammation of the mucous membrane of the tympanum are attended with intense pain, of a throbbing, darting, or bursting character, extending over the side of the head, often in the course of the nerves, and aggravated by swallowing or any other motions of the throat. There are loud and distressing noises, and the hearing is always greatly impaired; much fever too is present, and delirium often supervenes. These symptoms may either commence suddenly, in which case they generally follow exposure to cold or draught, or injudicious bathing; or they may gradually increase for two or three days, or the acute attack may supervene upon a state of chronic inflammation. On examination by the speculum, the meatus is generally found in a normal state, though it may be tender and tumid; the membrana tympani is sometimes actively congested and of a bright pink colour, at others it is only slightly reddened, dull, and mottled; and the vascular and swollen mucous membrane may be discerned through its semi-

transparent laminae. The throat is almost always actively inflamed. The act of inflating the tympanum, or of swallowing with closed mouth and nose, is acutely painful; if air enters the tympanum, the sounds are a gurgling or a prolonged creaking. There is often great tenderness over the mastoid process and immediately in front of the tragus. The treatment is that which is indicated by the pathology of the disease. In the most severe cases venesection is recommended by some authors, or cupping behind the ears. Leeches freely applied around the ear, and at the same time, perhaps, to the nasal mucous membrane, give great relief; and these may be repeated if the severity of the symptoms does not abate. Fomentations, steaming, and poultices, with all of which sedatives may be combined, and which the feelings of the patient demand to be used very hot, may be constantly applied; while aperient and cooling medicines, and morphia, or morphia combined with hyoscyamus, &c., in full doses, to procure sleep, may be administered. Some cases will improve rapidly under remedies of this kind: in others the symptoms are more obstinate, and all authors unite in recommending the administration of mercury in the form of calomel and opium; a point on which I can offer no opinion, not knowing any evidence by which the comparative progress of the disease, when these remedies are given or withheld, may be tested.

After a few days the severity of the pain generally diminishes, and in the most favourable cases the disease terminates either in resolution, or, when the secretion has been but slightly increased, in discharge through the Eustachian tube. In the latter case, the passage of the matter into the pharynx is often felt by the patient, and indications of it may sometimes be seen by the surgeon. When either of these events occurs—the resolution of the inflammation, or the discharge of matter by the Eustachian tube—the symptoms gradually subside. In time the organ may perfectly recover its normal appearance and function, though it is generally several months before the restoration is complete. Continued stimulation around the ear, and inflation of the tympanum with steam containing the vapours of iodine, acetic ether, &c., may perhaps expedite this process. The use of alkaline solutions through the nose is almost always of value.

In another class of cases, the matter discharges itself through the membrana tympani. This also may result in perfect re-

storation. The ear should be kept clean by the free use of lotions, either alkaline, or of perchloride of mercury, or in the later stages of sulphate of zinc, used as before described. Mild counter-irritation may be perseveringly maintained, and tonics, and possibly iodide of potassium administered, the general and local hygiene being also assiduously attended to.

A case is related by Triquet of acute inflammation within the tympanum arising upon the disappearance of an eczematous affection of the skin. A blister was applied to the nape of the neck, and the blistered surface became the seat of a similar eruption, on the access of which the aural disease subsided. Acute inflammation of the tympanum may run on to caries of the bone, and secondary intracranial disease; but such effects are far more frequent in the chronic form of the disease. Paralysis of the portio dura nerve may also accompany it: but this complication does not generally require special treatment. When it remains after the aural inflammation appears to have been cured, galvanism is said to have been found useful; but a thorough examination of the tympanum should be made.

Accumulation of mucus within the tympanum.—This is one of the most frequent forms of disease of the ear, and in its after consequences I am convinced one of the most frequent, and most irremediable causes of deafness. Happily it is, not only in its earlier stages, but even after it has existed for years, entirely curable, by the incision of the membrane and washing out the abnormal contents of the tympanum. When the shape and relations of this cavity are considered, and that it is subject to the very same affections as the adjacent mucous surfaces, it cannot be matter of surprise that under a great variety of circumstances collections of viscid and tenacious mucus should form in it, that can by no possibility escape by the Eustachian tube. Indeed, these aggregations of mucus are often so dense that they do not even gravitate to the lower part of the cavity, but cling about the heads of the ossicula, and cause the membrane to bulge or to become atrophied at the upper and posterior part. At other times they consist of a very thin fluid, which moves freely in the tympanum, and may be seen through the membrane to shift its position with the motions of the head. The patient will often complain of distinctly feeling something moving in the ear, and will acquire the habit of giving the head a peculiar shake with the view of moving it. In some cases I have found the collection to consist of two distinct portions—a thinner, escaping

freely on incision of the membrane; and a thick tenacious residuum, the evacuation of which is a matter of considerable difficulty.

The most frequent cause of the condition is a severe attack, or repeated slighter attacks, of a common cold, and though it is by far more frequent in the young, it may exist at every age. In one patient of sixty-seven, incision of the membrane and evacuation of a tenacious matter gave satisfactory results. After the affection has continued for some time, the membrane becomes considerably changed; apparently from the pressure of the fluid, it loses its elasticity, and becomes thinned in certain parts, especially in the region of the stapes; and as the Eustachian tube is almost always closed, the membrane is often irregularly drawn in—in some cases even lying in contact with the inner wall of the tympanum, at other times it distinctly bulges, and generally, though not invariably, the light yellowish colour of the mucus may be discerned through it. Sometimes bubbles of air may be seen outlined on the inner surface of the membrane. The diagnosis is generally easy, and is made chiefly by inspection of the membrane and inflation of the tympanum, either by the patient himself, by Politzer's process, or by the catheter; the air entering the tympanum with a distinctly moist sound, of various kinds. When the affection is in its first stage the membrane is red and vascular, often bulges considerably, and pain is present. The 'Ear-ache' of children, followed by discharge, even though it is slight and very soon over, I believe, is most frequently an affection of this kind. I have seen under such circumstances, a minute opening form in the membrane, discharge for three or four days, and close.

In quite recent cases the symptoms may entirely subside, the excessive secretion appearing to be gradually absorbed or escaping by a small orifice through the membrane, under a treatment consisting merely of general management combined with counter-irritation and washing out of the throat; but even in these, the question of incising the membrane, with a view either to save it from extensive ulceration or to guard against future obstruction of the tympanum, is one deserving careful investigation. But in confirmed cases, where there exists no inflammatory action, but merely a chronic or intermittent deafness, with liability to repeated colds, the one treatment that it is rational to apply, or that yields any permanent success, is to incise the membrane, and by a free stream of liquid, as described

under 'Perforations of the Membrane,' p. 278, thoroughly to cleanse out the tympanum. In a word, the case should be converted into one of perforation, and treated on the same principles. As a rule, the incision heals, even if it be syringed through daily, in four or five days, nor is it desirable to attempt to keep it open longer. Very often, however, more than one incision is required, and the amount of dense mucus that may be thus removed, even in cases where there has been no indication of any very excessive quantity, is often truly surprising, and can only be accounted for by supposing that it has been crammed into the mastoid cells and gradually makes its escape as the tympanum is cleared. It may sometimes be seized by a forceps, as it protrudes from the orifice after inflation of the tympanum, and drawn out as a viscid mass into the external meatus. I have removed in this way a mass twice the size of a marble, and with immediate, and so far permanent, restoration of the hearing, in a case of continually recurring deafness extending over five years. Many of these cases may be temporarily greatly relieved by the inflation of the tympanum and other means, but they relapse again and again, and lapse finally, in my belief, into confirmed deafness, constituting, *e.g.*, probably the larger part of the cases of 'thickening of the mucous membrane of the tympanum,' and no inconsiderable section of those of 'nervous deafness.' The great importance of a really rational treatment of these cases lies, of course, in its prevention of incurable consequent mischief. The tendency of these mucous accumulations is to become more and more dry and tenacious—they may be traced, indeed, through stages of this drying process—until they come fatally to clog the passage of sound. And they appear to work more disastrously still, by exerting an influence upon the labyrinth, and destroying by degrees the perceptive as well as the conductive power of the organ. It is my belief that if this affection were always rightly treated in its earlier stages, at least a third of the cases of confirmed deafness would be averted.

In its later stages, when the mucus has become dried, the diagnosis is much more difficult, and indeed it must rest largely on the history and on general inference. The appearance of the membrane, however, is often a very considerable guide; a general whiteness, *e.g.*, or especially a white streak posteriorly, or a rim of white thickening at the upper part. In many of these cases, considered hitherto as 'thickening,' I have found

the incision of the membrane, and washing out the cavity, of great service, especially if it is first prepared for by the repeated injection into it of solvent liquids, as described hereafter.

The mode of making the incision is very simple. I use a very small double-bladed knife with a thin handle, and make the incision (unless a special bulging indicates another spot) always behind and parallel to the malleus, between it and the incus, and carry it from near the upper border to near the lower. I seek especially to open the upper and posterior part of the tympanum, because I am convinced that it is there especially that the more viscid class of secretions chiefly collect, and it is there also that they are most mischievous. If the knife does not penetrate too deeply, there is no danger of dividing the chorda tympani. Once only have I noticed any symptoms due to this cause, viz. a tingling running down to the tongue during the incision, and a marked diminution both of taste and of general sensibility of that side of the tongue, passing off in a few days. In this case, however, a good deal of pain was complained of after the incision. I have said the incision heals in four or five days, and this is the case unless irritation should set in, as occurs now and then, in which case the healing is delayed perhaps for ten days or a fortnight. On each of the four days subsequent to the incision, if no irritation arises, I syringe a strong solution of soda through the tympanum by the meatus. On the fifth day the orifice is generally closed, but if it be not I suffer it to heal, and repeat the incision at the interval of a week or more if its repetition is indicated. Generally, if the case is a suitable one, an immediate improvement occurs. Sometimes the contrary is the case at first, even when the ultimate result is most satisfactory. Sometimes, of course, no benefit has ensued, and the hearing has been for a time considerably impaired; but I have not yet met with a case which I have been able to keep under observation, in which the original condition has not been after a few months completely regained. The proceeding itself, with care, seldom seems to give any shock to the system: once only, in a child who had suffered from convulsions previously, did convulsions follow shortly after the incision of both membranes.* But I have found that whenever any decided treatment is used to the tympanum,

* As an universal rule I apply any powerful local treatment only to one ear at a time, and to the worse first.

in a certain number of cases the *meatus* becomes inflamed. This, though it exerts no injurious influence on the progress of the case, is exceedingly painful and discouraging. I know no way of avoiding it but great caution in the applications, nor does this always succeed. The pain subsides in a few days. Hot poppy fomentations, warm lotions of liq. opii sed. (m v—xx ad 3j.), and ointments containing aconite, give most relief. An incision through the inflamed structures down to the bone, especially of the superior or posterior walls of the meatus, not only gives immediate relief to the pain, but is of great service to the original disease, especially when there have existed symptoms of cerebral irritation.

For this method of treatment is of eminent use in a large number of cases in which general nervous derangement has co-existed with obscure feelings of distress connected with the ear and head. In such cases, if an excess of mucus exists within the tympanum, the evacuation of it often gives the greatest relief. And I have found, both in these and in other cases, the membrane extremely dense and resisting to the knife, showing that it had offered, through the effects of disease, an unnatural resistance to the escape of the retained secretion. This condition of the membrane appears to be scarcely less frequent in young children than in adults.

It is probable that not a few cases of incomplete deaf-dumbness originate in disease of the tympanum, attended with such hyper-secretion. Nor does it seem unreasonable to hope that a practice founded on this belief, and not too long delayed, might here and there, where the symptoms and history suggest this cause, yield satisfactory results.

The incision of the membrane is not usually severely painful; in some cases it is scarcely painful at all; in others it gives rise to feelings of sickness and prostration for a few minutes. If the membrane is inflamed and tender, however, it is acutely painful for the moment. The patient should be prepared to keep the head resolutely still for the few seconds the incision demands, but it should not be fixed, lest not being able to move *away* from the surgeon's hand, he should suddenly move towards it. This is a precaution I employ in all operations in the immediate vicinity of the membrane. In children anæsthesia is desirable. The nitrous oxide produces an amply long effect, but the child is apt to be restless under it. Chloroform induces a more perfect stillness, and the syringing through the

ear may be carried out before recovery. It is needless to say that any blood should first be carefully syringed out of the meatus. I generally advise a lotion containing soda and liq. opii to be poured (warm) into the ear twice a day until healing has taken place. If any irritation of the meatus exists, it is desirable to subdue it before making the incision, or at least to proceed very cautiously afterwards.

A peculiar inflammation of the tympanum also accompanies various febrile diseases, especially the zymotic diseases of childhood. In scarlatina it is especially frequent, but it occurs also in measles, and in hooping-cough. I should suspect that it was common in croup, since in two fatal cases of that disease, which I examined, it was present in both. The tympanum becomes filled with pus or puriform mucus; its mucous membrane thick, red, and velvety, often so swollen as almost to fill the cavity, and it easily peels off from the bone; presenting in all these respects a marked contrast to its properties in health, when it is so thin and delicate as scarcely to be recognisable, and adheres with unusual firmness to the osseous walls of the cavity, to which it serves as a periosteum. The mastoid cells generally participate in the disease, and are also found full of fluid.

One peculiarity of this class of affections is, that they are apt to excite no attention. It is seldom that any indication, at least any one that would be observed by a person not on the watch for it, is given of the inflammatory action within the ear; and the first symptom that is noticed is a discharge from the meatus, which occurs, for the most part, only after irreparable injury has been done. Should it not, therefore, be a rule with the medical attendants of children suffering from any of this class of diseases to prove the absence of this affection of the tympanum, by examining the membrana tympani with the speculum and lamp, instead of assuming that it is not present unless palpable symptoms force it upon their notice? Such an examination, it seems to me, should be held imperative, at least in every case in which anomalous symptoms arise, and the patient's general condition seems worse than the progress of the disease might have given reason for expecting. The appearance presented by the membrana tympani is quite sufficient to determine the presence, the nature, and even the stage of the disease. The inflammatory action commencing *within* the tympanum, the external layers of the membrana tympani retain their transparency, and permit either the opaque fluid or the

thickened and congested mucous lamina of the membrane itself to be clearly distinguished through them. This is an appearance which, once seen, can hardly be mistaken. In the early stage of the affection the membrane presents an increased concavity, owing, I presume, to closure, by thickening of its lining, of the Eustachian tube; and there is often no other alteration in its appearance, except a bright pink colour seen *through* it. In the later stages the membrana tympani grows flat, it is dull and sodden in its hue, and at length manifestly bulges outwards before the accumulated secretion. The treatment would be guided by circumstances. In the slighter cases it might be possible, by antiphlogistic means, to subdue or check the local inflammatory action. In patients prostrate from severe scarlatina, or the like, it might be hopeless to attempt this, but excellent results might probably be expected from incision of the membrane. If, as in a case mentioned by Abercrombie, a discharge of matter from the ear restored to health a woman who had lost consciousness, might it not preserve from death a child depressed already to the lowest point by the poison of scarlatina? Might not such a patient's tenderer brain and feebler powers succumb entirely to a source of irritation which could produce symptoms so grave in an adult unaffected by other disease? I do not hesitate to avow my conviction, that by a prompt attention to the condition of the ear, and prompt evacuation of pus from the tympanum when evidence was given of its presence there, the balance might often be turned between life and death, and the mortality from scarlet fever and the allied disorders notably diminished. What else does the following report indicate?

A girl, aged eight, died in convulsions after scarlatina. No important disease was found, but the tympanum on each side was full of purulent matter, the membranæ tympani slightly bulging. It is true the urine was albuminous; but is it not so in very many cases of scarlet fever that recover? There was no decided disease in the kidneys. A case is reported by Mr. Harvey,* in which the evacuation of matter from the tympanum in acute scarlatina seemed to be attended with the best results. I have met with a case, a child aged five years, who had been deaf since the measles, two years before, in whom a mild attack of scarlatina very considerably improved the hearing. The membranæ tympani in this case were normal. In another case, of chronic deafness in a man aged thirty, scarlatina produced a similar effect.

Deafness often supervenes in the course of typhus or typhoid

* *The Ear in Health and Disease*, p. 101.

fever. In some of these cases it seems to be due to a peculiar form of inflammation of the tympanum. The cavity becomes the seat of a sanguineous effusion, which is found after death either in a fluid or coagulated state. The mucous membrane seems at the same time disorganised, and the osseous walls may be soft and infiltrated with red fluid. A considerable proportion of the cases of confirmed deafness met with after fever, are probably of this kind; but not all of them. For sometimes the tympanum is found quite healthy, and the cochlea, or vestibule, or both, contain an effusion of bloody fluid; sometimes no appreciable alteration of any part of the organ is found, though the loss of hearing has been complete.

A collection of puriform mucus is found so frequently in infants after death, that it seems to have given rise to the opinion that the tympanum, during the first period of life, is naturally filled with mucus, and that children only begin to gain the faculty of hearing about the third month. I have convinced myself, however, by repeated dissections, that the tympanic cavity is, in the healthy state, quite free from mucus, and that the membrane lining it is thin and delicate, at the very earliest periods. But in a large number of children, especially those suffering from other affections of the mucous membranes, and particularly of the lungs, the lining membrane of the tympanum is thick, red, and soft, and the cavity is filled with mucus, often of a purulent character; the Eustachian tube, by reason of its thickened lining, being impervious to the fluid. The condition, in short, precisely resembles that which occurs in scarlatina, except that it is less intense and comes on less rapidly; and the membrana tympani exhibits, on inspection, a similar appearance. I have so frequently found this state of the tympanum, in children, associated with convulsions or other symptoms of cerebral irritation, that I believe it stands to them in the relation of a cause. And if the pressure of a tooth upon the gum may so act upon the delicate nervous system of a child as to cause convulsive seizures, surely it is not improbable that the pressure of a mass of thick mucus, unable to escape from the tympanum, and probably being constantly increased in quantity even through its own irritation, might have the same effect. The intimate relation of the middle ear to the brain, and the close sympathy that exists between them, is proved by many well-known facts. Even a stream of cold water, applied

without force to the membrana tympani, may cause fainting in a strong man.*

Cases illustrative of the co-existence of convulsive disease in children with the above-described condition of the tympanum, are related in the 39th volume of the *Medico-Chirurgical Transactions*, and in the *Transactions of the Pathological Society for 1857*. Perhaps it would not be unreasonable that whenever a child has a fit, or manifests any symptoms of nervous irritation without an obviously sufficient cause, the state of the tympanum should be examined: in short, that the ear should receive the same attention that is universally given to the gums. This is the more necessary because the symptoms of this morbid condition are very apt to escape observation; those which I have noticed to be most frequent are a habit of putting the hands to the ears, or rubbing them; a cry of real pain when the ears are roughly washed; pleasure taken in having the meatus gently irritated, as by the head of a pin. In these, as in all cases of cerebral irritation, the child cannot bear to be jumped or otherwise violently moved. In one instance the child had been noticed to throw himself upon the ground and roll about, apparently in play, yet so strangely as to attract particular attention. The habit of rubbing the ears seems the most constant symptom, and one to which (as in the parallel case of dental irritation) special attention should be paid. These patients are sometimes noticed to be deaf; more frequently, especially among the poor, not so. Often they are thought to be stupid or inattentive. And here I cannot refrain from observing how frequently this is the case with children who labour under incipient deafness, and how strong a claim they have upon the surgeon to stand between them and their ill-judging guardians, and save them from the grievous wrong and injury that are too often inflicted upon them, under the idea that what is truly due to a physical infirmity results from moral fault. Too often blows are inflicted as punishment, which directly aggravate the disease. In the case of a youth who died with caries of the petrous bone and abscess in the cerebrum, and in whom the symptoms of aural disease dated

* Convulsions are enumerated among the causes of deaf-dumbness; but there is every reason to believe that in some of these cases the connection of events lies the other way, and disease in the tympanum has been the cause of the convulsions.

from early life, his father had been in the habit of boxing his ears for 'inattention.'

In the treatment of this class of cases, incision of the membrane should doubtless be insisted on, but I have had less opportunity of testing its effect. They are for the most part seen only by the ordinary medical attendant, and no advice is sought for the ears. Attention to the general health and to the condition of the fauces of course are necessary, and I have thought also that the application of the tincture of iodine to the neighbourhood of the ear, and the internal administration of the syrup of the iodide of iron, have acted favourably.

Inflammatory thickening and hypertrophy of the mucous membrane of the tympanum are met with, for the most part, in connection with destruction, more or less complete, of the membrana tympani. Sometimes, though more rarely, they exist while the membrana tympani is perfect, being due in all probability to repeated attacks of subacute inflammation, especially in a strumous, gouty, or rheumatic constitution. The membrane is red, soft, and velvety, and may be so tumid as nearly to obliterate the cavity. The membrana tympani is more or less fallen in, opaque, thickened, and with a slightly reddish hue; congested vessels may be visible on its surface. The Eustachian tube is obstructed, or air enters with a creaking sound, as if forcing its way through an almost obliterated passage. The diagnosis, however, is difficult; the prognosis not favourable. Besides the ordinary local and general measures, small doses of the bichloride or biniodide of mercury may be given, in bark, or combined with the iodide of iron, and of potassium, for a considerable period; or any medicines adapted to combat the rheumatic habit, if it be evidently present. Too much stress, however, cannot be laid upon the regulation of the mode of life. A careful diet, exercise, avoidance of close atmospheres or sudden variations of temperature, may at least delay the progress of the disease.

Syphilitic inflammation of the tympanum.—It cannot be doubted that deafness is sometimes due to syphilitic affections of the middle ear; but these cases are rather to be distinguished by the history than by the condition of the organ.

Deposits within the tympanum.—Cholesterine is sometimes found in this cavity and the mastoid cells in considerable masses;

chiefly in advanced life. Another form of deposit, which occurs for the most part in the young, is probably of a tuberculous character; it is a soft caseous mass, consisting of degenerated cells and granular matter. In these latter cases there is most frequently a secondary or coincident affection of the brain. Dr. Gull* questions whether these deposits are of a strumous character, and holds that they consist simply of inspissated and degenerated pus. The coincident affection of the petrous bone seldom presents the characters of strumous infiltration, but rather those of ordinary caries. Yet cases occur in which the tubercular character of the affection can hardly be doubted; for example, where tubercle exists also in the lungs, or where, as in a case reported in vol. xxxix. of the *Medico-Chirurgical Transactions*, tubercular masses, of a similar character, exist in the tympanum and the adjacent portions of the brain. In the case of strumous deposit within the tympanum, the membrana tympani generally ulcerates, and exposes the cavity. The treatment naturally suggests itself; but it is of course doubtful whether any treatment could be of avail. In the later stages of phthisis ulceration of the membrana tympani is a frequent symptom.

Membranous bands, extending between different parts of the tympanum, and connecting the ossicula to each other or to the walls of the cavity, are frequently met with after death. Respecting these I have made two observations, which appear to me to be of interest. The first is, that mere mucus in the tympanum, if exposed to the air in a dissected petrous bone, will in the course of a few days dry up into broad bands, undistinguishable by the eye from those which are so frequently met with. It is true the 'bands' thus formed present no structure under the microscope, while some of the membranous adhesions which are found already existing on dissection have a fibrillated appearance. Yet it seems probable to me that mucus may dry up within the tympanum during life, and may thus give rise to the appearance of bands in some cases. I am induced to hold this opinion from the extreme frequency with which these membranous bands are found. Bands were present in 271 out of 1,149 dissections of diseased ears made by Mr. Toynbee, and in 30 out of 94 such dissections made by myself.

* *Guy's Hospital Reports*, vol. xxxvii.

They occur also in cases in which there is no other appearance of inflammation, and indeed where the probability is very strong that it has never existed. I have found a very broad and distinct band in the mastoid cells of an infant four months old. It is hard to understand how real fibrinous adhesions should form in such a cavity as the tympanum without the effusion of a considerable quantity of lymph, which must involve, one would suppose, an attack of inflammation of a formidable kind. I have observed, also, that membranous bands in the tympanum do not seem to affect the hearing to an inconvenient degree, unless they also interfere with the motions of the ossicula.

An irregular concavity of the membrana tympani, the Eustachian tube being pervious, may give ground for suspecting the presence of such bands, which will be rendered more probable if there be a history of previous inflammation. But a little instrument introduced by Dr. Siegle, and termed by him the 'pneumatic speculum,' renders their detection, when they exist to any serious degree, more easy. This instrument consists of a small box, having a slightly magnifying lens for one end, and at the other terminating in a speculum which is made to fit the meatus air-tight by means of a piece of elastic tubing placed over it. From the box there passes off also a tube ending in a mouth-piece. If, now, having adapted the instrument to the meatus, the surgeon applies suction by the tube, and at the same time keeps his eye fixed upon the membrane through the lens, it will be seen to move outwards, and may be made by modifying the air-pressure to move to and fro. If it is bound down by adhesions these will reveal their presence by their interference with its movements. They are by no means an insuperable cause of deafness. Not seldom they may be ruptured by a powerful inflation of the tympanum on Politzer's plan. The patient feels a sudden snap in the ear, and at once hears better (for the most part), and on examining the membrane a distinct effusion of blood on its inner surface may be seen, which is absorbed in a few days. The inflation needs to be carefully continued. In other cases, if the nervous power is preserved, injection of the tympanum with solvent fluids, as described under 'Rigidity of the mucous membrane,' is often useful. The same means, combined with the use of the catheter and bougies to the Eustachian tube until it is freely pervious, are efficacious also in some of these cases in which there exists more or less complete disorganisation of the tympanum from

the effects of former inflammation, and the membrana tympani, though not perforated, is fallen in and lies in contact, or nearly so, with the promontory, while the soft structures are infiltrated with hardened secretion, and converted into dense and rigid masses. The power of hearing, in some of these patients, is greater than the condition of the visible portion of the ear would lead us to anticipate; and even the worst cases need not always be entirely abandoned. It is often the case that when one ear is much less sensitive than the other, the patient acquires the habit of entirely disusing it, and of relying solely upon the better organ. Thus the function of the injured ear becomes deadened from mere lack of exercise, and it is capable of being roused by use to greatly increased sensibility. Sometimes persons who have thus suffered one ear to fall into disuse, are unfortunate enough to meet with an accident, or suffer a disease, which destroys the other, and then they may obtain great relief by bringing into use the latent powers of the neglected organ. By means of a hearing-trumpet, or sometimes without it, an ear long supposed useless may be brought, through persevering exercise, to play a very serviceable part. On the same ground, it should be a rule with the surgeon to encourage those who have sustained irreparable injury to one ear, short of total deafness, to maintain it in exercise by using it alone for a certain period every day. Those, also, by whom hearing can be performed only with difficulty through disease of both ears, should be instructed to exercise what power may remain, instead of relying on the sight alone; and their friends should be willing to aid them in this endeavour.

Rigidity of the mucous membrane of the tympanum.—I retain this expression, though I feel that at present its signification must be held quite doubtful. It is not unlikely that the rigidity of the membrane may arise, in the large majority of cases, from the gradual drying of retained secretion. But the data are not yet available for determining this point, nor is it, at least in confirmed cases, of practical importance. Whether the mucous membrane be, according to Mr. Toynbee's view, 'rigid' from slow inflammatory or degenerative action, or be rendered so by condensed secretion, the effect doubtless in impairing the motions of the ossicula is the same; and so also is the treatment. If there be vigour in the patient's constitution, and the nervous power seems to be moderately well maintained (as *e.g.* if the tuning-fork be better heard in the worse ear),

benefit is generally derived from the continued injection of solvent or astringent liquids into the tympanum.

There is one qualification to this remark, however, viz. that when a true bony ankylosis of the stapes exists, benefit cannot be expected, and I do not know any symptoms by which it can certainly be distinguished during life. I believe, however, from the result of my dissections, that this is a decidedly rare affection except in the aged, and, I think, that symptoms of nerve-failure generally accompany it. In cases of 'rigidity,' the meatus is frequently found devoid of cerumen; the membrana tympani is either natural or slightly opaque; occasionally it may contain calcareous deposits. The Eustachian tube is pervious; and the air enters often with a loud or a wheezing sound. No pain is present; but there is generally an annoying tinnitus. The 'adapting power' of the organ is more affected than the mere ability to distinguish sounds. The patient is embarrassed in general conversation, while able to hear single voices with tolerable ease. This symptom, however, may also exist in cases of nervous deafness, arising from the excitement connected with a large company; but the mode of its production is different, and in the latter cases excitement produces the same effect under all circumstances. Hearing better in a noise, as while riding in a carriage, or during the beating of a drum, appears to be common to this with some other morbid conditions.

It has been recommended to treat this affection with counter-irritants, nitrate of silver applied to the membrana tympani, baths, and inflation of the tympanum with medicated vapours. But, I believe, the only plan which is at all reliable, is to inject at short intervals into the tympanum medicated solutions. Those which I chiefly use are carbonate of soda (gr. x.—xx. ad ʒ), hydrochlorate of ammonia gr. x. ad ʒj., with which I usually combine perchloride of mercury (gr. $\frac{1}{8}$); and sulphate of zinc, gr. ij.—vj. ad ʒj.;—the first as a mere solvent, the second as stimulating and absorbent, and the last as an astringent. But various others, as liq. potassæ, tinct. iodine, and arg. nitr. in small quantities, are recommended, and probably have special advantages in some cases.

There are two ways in which they may be applied, the best is to introduce a few drops by means of the Eustachian catheter, through which it is easily blown into the tympanum by an elastic bag. This may be done from once to three times a

week, and continued for three or four weeks. If it is beneficial it can be resumed at intervals. At the same time friction with iodine and ammonia, or occasional blisters, can be employed; and the throat should be kept clear by solution of soda drawn or syringed through the nostrils. Many cases that would otherwise have been hopeless, may by this means be very greatly improved. It requires of course the continued attendance of the patient, and when this is impossible, or seems not justified by the probability of benefit, this may be dispensed with (although not without some disadvantage), and he may himself force a solution of soda or ammon. hydrochl. into his own tympanum once or twice a week. The method of doing this is very simple, and was first pointed out by Dr. Gruber, of Vienna. The patient inclining his head well to the affected side, introduces into the nostril of the same side a glass syringe containing about ʒij. of the solution. This he syringes firmly into the pharynx, where it lies in contact with the orifice of the tube. He then quietly and without swallowing inflates the tympanum. With a little practice he thus quite easily forces a little of the liquid into the tympanum. If the tube be not pervious, of course it must first be made so, and before this plan is adopted, it is well to clear the posterior nares and pharynx well by a solution of soda, through the nose, twice daily for a week. There is more risk of irritation on this plan, but I have known it also answer very satisfactorily, and in cases of long standing.

Warm vapours containing iodine, &c. introduced through the Eustachian catheter, by means of an air press, or an elastic bag, though less useful, appear sometimes efficacious, and often form a valuable adjunct. But *the* remedy is liquids.

Dr. Weber, of Berlin, has suggested the introduction of a very small elastic tube through the ordinary catheter, quite into the tympanum—a proceeding perfectly feasible—and by means of it the direction of a stream of medicated spray to any desired region of the tympanum. By this means much stronger solutions may be employed with safety, but perhaps the difficulty of deciding when and at what point they are required, will for some time remain.

In some obstinate cases I have seemed to find benefit from the biniodide of mercury (gr. $\frac{1}{32}$), combined with syr. ferri iodidi ʒj., and potass. iod. gr. ij. *ter die*, continued for some weeks. As a rule I use the solutions only to one ear at a time,

and having thus a point of comparison, I have been able to convince myself of their benefit in some cases in which, at the patient's own request, they have been employed at intervals for upwards of two years. But, I think, no skill in diagnosis can, with our present knowledge, avoid failures; especially perhaps in young women, who, as a class, are very liable to this or some like form of deafness. General tonic regimen and especial avoidance of close rooms and other causes of catarrh, and also of the too free use of cold water to the head, are of course to be insisted on.

This form of disease, together with that next to be mentioned, has been ascribed to a gouty or rheumatic constitution. On this point, however, farther investigation may be needed. Dr. Garrod informs me that he does not find gouty or rheumatic patients especially liable to deafness, the ear forming in this respect a decided contrast to the eye; and Dr. Gull has submitted to examination some deposits from the tympanum supposed to contain acicular crystals of uric acid, and has found them to consist of fat.* The best-marked case of the connection of deafness with the gouty diathesis that has come under my own observation is that of a lady, aged fifty-seven, subject to attacks of gout, and slightly deaf. On the occasion of the sudden death of her husband, an intense deafness came on in the course of a few hours, which subsided on the local manifestation of gout two or three days afterwards.

Anchyllosis of the stapes to the fenestra ovalis.—This is an affection our chief knowledge of which we owe to Mr. Toynbee. It consists in a union, by bone, between the base of the stapes and the margin of the fenestra ovalis. This condition may exist in various forms, either that of a simple expansion of the base of the stapes, or an expansion combined with a calcareous whiteness of the bone, or with effusion of osseous matter within or around the joint. In some cases, there is found a thickening and rigidity merely of the ligaments connecting the articulating surfaces. The general symptoms are very like those of the last-mentioned affection. How far treatment is of any effect, there is as yet no sufficient evidence to show.

In Canstatt's *Jahresbericht* for 1859 is an account of a paper by Voltolini on this subject. Taking into consideration the very slight amount of motion normally possessed by the stapedio-vestibular articulation, it appeared to him

* *Guy's Hospital Reports*, 1857, p. 289.

unlikely that the deafness which occurs in its ankylosed condition could arise from its immobility. Experimenting upon the subject, he found that vibrations were transmitted best from air to a limited surface of water, when the latter was covered by a plate, which was not solidly connected to the boundaries of the aperture. It is to the alteration in this respect, therefore, and not to loss of the motion which might be given to it by the muscles of the tympanum, that he ascribes the deafness which accompanies osseous ankylosis of the stapes. In respect to the diagnosis, he rejects the relatively greater inability to understand mixed conversation than to distinguish single sounds, and relies chiefly on the appearance of the external portions of the ear:—the meatus dry, widened, without vital reaction, and leathery; the membrana tympani parchment-like, dry, thick, opaque, sometimes with earthy deposits, and immobile. The affection occurs, too, in dry and harsh constitutions. The sound, on inflation of the Eustachian tube, is normal, or too full, and the act produces no improvement. He rejects all treatment.

In connection with this affection, Mr. Toynbee has reported a case in which a great temporary improvement was effected by a loud shout uttered close to the ear; this improvement being ascribed by him to a loosening of the stapes within its articulation. Perhaps the following case, related by Triquet, was one of a similar nature. A man had suffered from deafness, coming on gradually for many years, without any known cause. It was attended with tinnitus. In a fit of despondency he fired a pistol into the right ear. The bullet destroyed the auricle and fractured the meatus, passing out beneath the scalp. The hearing in that ear was raised by the shock from two to twelve centimetres. I have also seen a gentleman in whom deafness of several months' standing suddenly ceased on an engine passing close to him with a loud whistle. The ear in this case (some years subsequently) showed nothing abnormal.

Indeed, the causes which will sometimes seem to improve the hearing in cases of deafness are such as we could by no means anticipate. An elderly lady, who had been under my care for deafness, attended with perforation of the membrana tympani, was seized with paraplegia. The hearing became decidedly better at the time of the attack, and continued so for some years.

Exostoses, or deposits of osseous matter, are occasionally found on the other ossicles.

One case also is on record of *fracture* of the handle of the malleus. It was found in the body of a man who died in Guy's Hospital from disease quite unconnected with the ear, and is reported in the *Pathological Transactions*, vol. x. p. 236. The fracture took place just above the processus brevis, at the point where the tensor tympani ligament is attached; the fractured surface was smooth and convex, and seemed to have played on a false joint upon the body of the malleus, which was displaced inwards. I have seen another also, produced by a sudden blow while picking the ear with a wire. The deafness was very great.

Dislocation of the ossicula is more frequent; it generally occurs between the incus and stapes, and is accompanied with

caries of the bones, or other effects of inflammation. In the severer forms of inflammation of the mucous membrane of the tympanum, indeed, caries of these bones is not an unfrequent result. For the most part, when this occurs, the membrana tympani is perforated; but this is not always the case. The head of the malleus, the incus, and one crus of the stapes, have been found to be destroyed by caries, the membrane being entire.* The patient was a woman aged thirty, who died of acute peritonitis. The artificial membrane is suitable for these cases.

In cases of perforation the incus frequently comes away in a more or less carious state; the malleus also, but less frequently; and still more rarely, the stapes may be separated from its attachments and cast off. Whether total deafness necessarily results from loss of the stapes, involving as it must do the discharge of the perilymph from the internal ear, is as yet undecided.

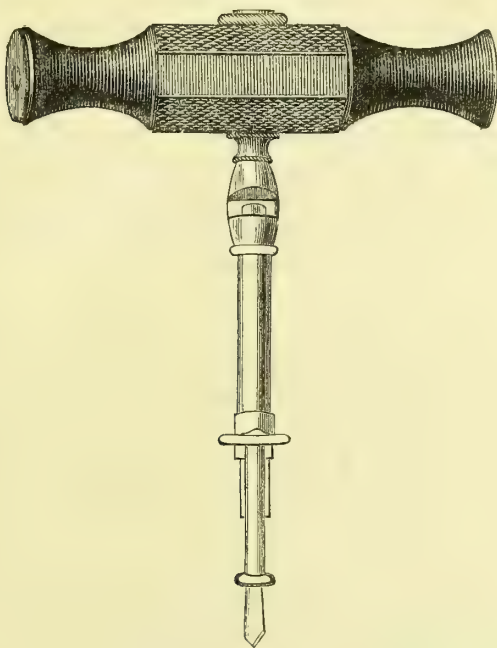
Diseases of the Mastoid Cells.

Besides participating, as they for the most part do, in inflammatory diseases of the tympanum, the mastoid cells are subject to affections which do not involve that cavity. They may be the seat, for example, of deposits, chiefly of cholesterine, while the tympanum is free; and inflammation leading to caries or necrosis of their osseous walls may co-exist, though seldom, with a comparatively healthy state of the adjacent parts. This latter affection is more frequent in childhood than in adult life, and, whether consequent upon disease commencing in the tympanum or not, demands prompt measures to prevent extension of the mischief to the intra-cranial organs. The symptoms are, tenderness over the mastoid process, followed by redness and tumefaction; a discharge generally issues from the meatus, although the walls of this passage may be perfect. Sometimes an obscure fluctuation may be felt behind the ear. There is generally at this stage of the disease headache, and pain extending over the back of the head and neck; often giddiness, and other symptoms of irritation of the brain. The most essential point in the treatment is not to neglect, nor to defer too long, an incision, freely exposing the bone. This should be made in the vertical direction about half an inch behind the ear, and

* Triquet, from the *Gaz. des Hôp.* Jan. 1851.

should extend the whole length of the mastoid process. Great relief almost invariably follows. Sometimes pus will escape, and the knife will penetrate the softened bone. Poultices should be applied, and a free discharge encouraged. Portions of dead bone may come away, or the wound may gradually heal without exfoliation. If the cerebral irritation should continue, a seton applied to the nape of the neck, or an issue in the arm, may be found useful, the utmost care being at the same time taken to insure a free exit for matter. There are now nearly twenty cases on record in which the mastoid process has been tre-

FIG. 150.



Instrument for perforation of the Mastoid Cells.

phined, or otherwise perforated, for the evacuation of matter contained within it. Of these it may be said that almost every one appears to have been successful that was not performed too late. The operation is a simple one, and by aid of the instrument (Fig. 150) may be carried out with great safety. It should never be neglected when, after the periosteum covering the mastoid process has been freely divided, symptoms of cerebral irritation still continue.

VI. AFFECTIONS OF THE LABYRINTH AND AUDITORY NERVE.

These are divisible into two classes; those in which demonstrable pathological changes are or are not present. But our knowledge on the subject, and our means of diagnosis, are both as yet very imperfect. Among the morbid conditions found within the labyrinth, the most frequent are: vascularity of the walls and membranous tubes; deficiency of the labyrinthine fluid; excess of otoconia; effusions of lymph, of red serum, or of blood, the latter being chiefly found after typhus or typhoid fever. The tympanic aperture of the cochlea has been found filled with osseous deposit. The auditory nerve is sometimes, especially in old persons who have been long deaf, atrophied, and much reduced in size.

In some instances, the bony portion of the internal ear becomes necrosed, and finds exit through the meatus externus without producing disease within the skull. In a patient of Mr. Shaw's, a boy who had suffered from scarlatina two years and a half before, almost the whole of the bony labyrinth was thus cast off, being removed by the forceps from the external meatus.* And in the case of an old man, who came under my own observation, the entire cochlea, with some of the adjacent bone, had come away.

Menière has reported two interesting cases:—

One of a girl exposed to severe cold for several hours, by having to travel in an open carriage at night, during the catamenial period. In a few hours she became completely deaf, without pain. Death soon followed. There was found, throughout the labyrinth, 'a sort of plastic, reddish lymph, which appeared to be the product of an inflammation of all the membranous surfaces which line the internal ear.' In another similar case, proving fatal in two months, there existed the same plastic lymph, of yellow colour, occupying the labyrinth, with a number of small grey, opaque points scattered through it, resembling commencing tubercle.

Few cases precisely similar to these have been met with since, but there is a frequent and well-marked affection which seems evidently to have some relation to them. The patient, probably entirely free from any previous affection of the ear, is suddenly seized with giddiness, and in severe cases with nausea, and finds himself unable to walk steadily; at the same moment he becomes conscious of a sound in one or both ears, which may be of various kinds; often it gives him the conviction of some external source of sound. The giddiness, &c., pass off in a few days entirely, but the hearing of one or both ears remains very greatly im-

* *Transactions of the Pathological Society*, vol. vii. p. 335.

paired, and the tinnitus continues. Of the condition of the visible parts of the ear at the time of the attack I cannot speak, but on examination, after the lapse of weeks or years, the tympanum appears quite normal; the nerve is partially paralysed. The pathology of the affection is not yet known, since it appears not to shorten life. My own guess is that the severer cases indicate apoplexy of the labyrinth; the slighter ones, probably, some sudden increase of fluid pressure. I have not found any remedies successful. It is natural to suppose such an attack to depend on general impairment of health, and in most cases the patient is weak or anæmic. But I have met with the symptoms in a strong young man in whom I could discover no other deviation from perfect health. With time the affection may be expected to become less severe.

Akin to this affection are certain acute affections of children, in which, after suffering from severe head symptoms, often with repeated convulsions, the child recovers, but remains totally, or almost totally, deaf. Some of these cases are probably, at the commencement, simply inflammation of the tympanum; but others, no doubt, involve the nervous centres. They will be understood when the ear is no longer thought too insignificant or too remote to receive the attention of the physician.

A form of 'nervous deafness' also follows parturition, the tympanum remaining healthy; but more often the deafness that dates from a confinement includes a chronic tympanic inflammation. Deafness sometimes co-exists with epilepsy, but the connection between the two affections is not clear. In one case, that of an otherwise healthy man, who had been the subject of syphilis, the hearing suddenly returned after a slight epileptic fit—apparently the only one—and has not been lost again.

Painful affections of the fifth nerve, besides their influence in inducing and maintaining disease within the tympanum, may apparently induce paralysis of the auditory nerve. The hearing may be suddenly lost after a severe neuralgia. Connected with this, probably, is a fact I have noticed, that in 'nervous deafness' the tympanum is not unfrequently partially anæsthetic.

Falls on the head paralyse the hearing, as also do loud and long-continued noises, such as those to which boiler-makers are exposed. I have met with a man who almost totally lost his hearing through being in a church belfry while the peal was rung. Rifle-shooting deafens in some the right, in others the left, ear. A cannon that is suddenly fired on the Rhine steamers,

to show an echo, has been assigned to me as the cause of deafness by more than one patient; as also has the sudden pressure involved in descending in a diving-bell. Quinine often produces temporary deafness, but I have seen no reason to believe this effect is permanent. An ounce taken by mistake at once produced deafness only for a time. The hearing is sometimes totally destroyed by scarlatina, evidently by some nerve affection. Mumps are peculiarly prone to induce an affection of this kind, the nature of which is yet unexplained. A sudden exposure to severe cold appears to influence the auditory nerve sometimes, as it does the facial. Tumours of the brain may have loss of hearing among their symptoms. But apart from any causes of a decisive character, a mere failure of the function of the nerve is frequently, though less frequently than has been supposed, met with among the deaf. It is easily recognised by the tests mentioned above; frequently an hereditary predisposition is present; the aspect is often peculiar, especially a certain look in the eyes; and for the most part there is aggravation of the deafness by excitement or depression of mind. Tinnitus, often constant, and of a very distressing character, is generally present.

Thus patients suffering from deafness due to conditions of the nervous system come under two classes: those in whom the affection is seated (probably) in the labyrinth, or auditory nerve; and those in whom the deafness is accompanied by general nervous debility, and is to be referred rather to the nervous centres. Among the latter are the cases of deafness arising from prolonged lactation, or the operation of other debilitating causes, such as fatigue in tropical climates, excessive exertion of body or mind, over study, sorrow, want of sufficient sleep. In persons predisposed to the affection, very slight causes may apparently determine its access. In one well-marked and severe case, it supervened upon the administration of a strong purgative. This form of deafness is by no means confined to adult life; if anything, it is more frequent in the young; and it may be met with among children at school, or subject otherwise to excess of study. Deafness has alternated with other affections as a result of worms.

I am of opinion that there may be a 'hysterical' deafness; at least, I have met with the case of a girl who suffered greatly from the confirmed intemperance of her mother, and who was liable to very complete temporary loss of hearing. It would come on rapidly, and disappear suddenly, the hearing being good in the intervals. The inspection of the ear revealed no disease.

The extreme slightness of the causes to which nervous deafness often appears to be due, early attracted my attention. I have known it brought on by a quarrel, and even assigned by a strong man to the excitement of requesting from her parents their daughter's hand. In this last case, however, it appeared that, a few years before, the patient had been stunned and partially deafened for a time by a fall down his college stairs. It is probable, surely, that the real cause of his deafness was this fall, and not the quite normal mental agitation with which its access coincided. And further observation has confirmed me in the opinion that the 'nervous' form of deafness, which follows trivial causes, is very often due to shocks or diseases long previous, of which the effects have remained, and were latent or unnoticed, until the occurrence of some slight accident. And among these 'latent' causes of nervous deafness I am disposed to assign a very important place to the 'ear-ache' which is so common in childhood, especially if it be *not* attended with discharge.

There is one symptom which is present in some cases of nerve deafness which appears to me of considerable interest, viz. an *inversion* of the normal effect on closing the meatus, while the tuning fork is placed upon the vertex. Very many patients, assuming instead of observing, will say at once that its sound is diminished, but need only to have their attention aroused to recognise that it is increased. But there are some who so persistently and intelligently affirm that it is diminished, and they form so consistent a group of cases, that it is impossible to question the fact. This diminution of the sound of the tuning-fork on closure of the meatus, appears to me at present to be explicable only as an indication of an increase of the fluid pressure within the labyrinth. I have not been successful in dealing with it.

The treatment of nervous deafness should be guided by the nature of the affection. If there be reason to suspect a syphilitic taint, or if the gouty or rheumatic diathesis be well marked, and there exist signs, however obscure, of an inflammatory or irritable condition of the labyrinth or nerve—as for example, the increase of deafness or of tinnitus by moderate stimulants, such as a single glass of wine—a corresponding antiphlogistic and specific treatment might be had recourse to. But for the most part, if the deafness be truly seated on the inner side of the tympanum, severe measures do unmitigated

harm. Repeated blistering may effect a temporary improvement, at the expense of a permanent aggravation. Some reliable authorities recommend the continuous galvanic current, but my own experience and observation have not been very favourable. I should confine its use to one ear. Whenever the affection can be traced to any debilitating cause, and it is of recent access, the removal of the cause with a general tonic hygiene may be attended with a perfect cure. Mr. Toynbee had great confidence in a combination of quinine and morphia in small doses, taken perseveringly once or twice a day. Stimulating liniments around the ears, perhaps containing chloroform, if tinnitus is a prominent symptom, are at least unobjectionable; and the use of cold water and friction may in most cases be advised. I have seldom known benefit produced by strychnia. Mr. Braid, in the *Association Medical Journal* for September 1855, has reported cases of 'nervous deafness' benefited by hypnotism. In some cases connected with fevers, the biniodide of mercury with iodide of iron have seemed to do much good.

There is a form of nerve-deafness clearly connected with over work; I should describe it as a kind of reflex irritation from the nerve of special sense, to the nutritive and muscular nerves of the tympanum. It is attended with more or less tinnitus, and symptoms of irregular action of the muscles of the ossicula, and there are slight appearances of congestion of the mucous membrane. But in the main the symptoms are those of impaired nerve power, and they vary decidedly with the general tone. The treatment should be very careful so far as local measures are concerned, and the prognosis, if taken in time, and rest secured, is decidedly favourable. Children born in the tropics are liable to become deaf about the age of puberty, and to baffle treatment, for some cause unknown. A form of hardness of hearing that closely simulates failure of the auditory nerve, appears to me to be dependent upon loss of power of the tympanic muscles—in short, a failure of the tympanic adjusting power. The inconvenience is not very serious, though it is annoying. The patient complains that he cannot follow general conversation, and on examination it is found that the tympanum transmits sound fairly, and that the hearing for single sounds is good, but that quick modulations of the voice cannot be followed. Galvanism might be useful in these cases.

If hearing-trumpets are had recourse to in these cases—and they are advisable when the deafness is confirmed—care should be taken that they are such as not to try the ear, by producing a loud metallic resonance. The patient's own sensations are the best guide in selecting them, and they should not be more powerful than is absolutely necessary. A very convenient form is one that passes by a spring over the head; and in the case of women it may be almost entirely concealed by the hair. Mr. Marshall's may be specially recommended.

Loss or diminution of the nervous power often co-exists with other diseased conditions of the organ, and may aggravate the effect of inflammatory lesions of the tympanum, membrana tympani, or meatus. In these cases the symptoms are of a mixed character.

A true *neuralgia* of the ear exists, though rarely, except as connected with disease of the teeth. It is strictly periodic; the ear is healthy in all respects, and the hearing is not diminished. It demands nothing peculiar in its treatment.

Tinnitus may exist as a symptom of the most various affections, from cerumen in the meatus to undigested food in the stomach; and its treatment is, in the main, the treatment of its cause. But when it seems to exist as an isolated symptom, and no cause can be clearly discovered for it, the remedy I have found best worth trying is scruple doses of hydrochlorate of ammonia three times a day. It seems sometimes to have the same power over tinnitus that it has over some forms of neuralgia. The bromide of potassium I have not found equally useful. Spirit of camphor and liq. opii, forty drops of each in an ounce of glycerine, have also given relief. Vapour of chloroform, applied through the Eustachian tube, has been recommended; but in very severe cases, as also in extremely obstinate neuralgic pain of the tympanum, I have found the injection of a few drops of a solution of atropine (gr. $\frac{1}{8}$ —3j.) the most effectual local application.

A loud report like a pistol, occurring frequently as sleep approaches, I believe to be due to over-fatigue; especially to over-fatigue of the better ear, in cases of one-sided deafness. Some persons are troubled with cracking in the ear, keeping regular time, but intermitting; it is due, at least sometimes, to an action of the tensor palati upon the Eustachian tube; in some other cases the tensor tympani is the muscle in fault,

and the malleus may be seen to move with each recurrence of the sound. Some persons have the power of voluntarily producing one or other of these movements.

Excessive sensibility to sound (or hyperacousia), and the perception of a second sound, often discordant, accompanying every tone (paracousia), are rare phenomena, except as occurring in the early stages of inflammation within the tympanum. They are, however, sometimes persistent, and occasion great annoyance. A case is quoted from Sauvage, in which a musician was compelled to give up his occupation because he continually heard a second inharmonious note with every note he played.

A buzzing sound, like the twang of a loose harp-string, sometimes accompanies particular notes. This occurs, I believe, during the early stages of catarrh. Inability to hear certain notes has been observed, and is ascribed to loss of power of certain special portions of the cochlea. Dr. Lucae relates a case of this kind in which he constructed 'resonators' answering to the missing notes, and by wearing these the patient regained the lost power.

Among the causes of deafness, having its seat partly in the nervous structures of the ear, must be mentioned *hereditary syphilis*. According to Mr. Hutchinson's experience, which my own has entirely confirmed, deafness of a very extreme character is frequent among this class of persons.

The general characters of the disease as described by him are present. The deafness occurs for the most part about the time of puberty, and rapidly becomes very intense. The tuning-fork is scarcely heard upon the head. The membrana tympani is generally but slightly altered, and the Eustachian tube is pervious. Among the poor and hardly-worked, the prognosis is very unfavourable; but among those more fortunately circumstanced, a satisfactory result may often be obtained. The medicine that has seemed most useful to me is the hydrochlorate of ammonia in \mathfrak{ij} . doses, but the ordinary mild specific treatment may be serviceable. Injection of vapour of iodine, or of the mixed solution of ammon. chlor. and hydr. perchlor. into the tympanum, have appeared to do most good.

VII. DISEASES OF THE EAR IMPLICATING THE BRAIN OR LATERAL SINUS.

This fatal class of diseases has been long recognised, but much additional light has been thrown upon their pathology by the investigations of Mr. Toynbee and Dr. Gull. The former has shown that inflammation of any portion of the ear, either of the meatus, the tympanum, the mastoid cells or labyrinth, may extend to the bone, and lead to a fatal issue; and has established it also as a general rule that disease advancing from either of these portions of the organ sets up morbid action in certain definite localities within the cranium. Thus inflammation of the meatus or mastoid cells tends to produce disease of the lateral sinus or cerebellum, except in young children, in whom the mastoid cells are very small, and are in relation rather with the cerebrum. Inflammation of the tympanum for the most part extends towards the middle cerebral lobe; and when the labyrinth is involved, which seldom happens except by extension from the tympanum, the progress of the disease takes the course of the auditory nerve towards the medulla oblongata. Other observers, while allowing the great exactness and importance of the relations thus pointed out, have held that exceptions occur, and that disease, commencing in any portion of the ear, may progress inwards by various routes.

The chief secondary diseases produced by aural inflammation are three: inflammation of the dura mater and the other membranes; abscess in the substance of the brain; and inflammation of the lateral sinus, with its effects. The two former of these affections are for the most part found together; but cases not unfrequently occur in which, while the dura mater is inflamed, the cerebral tissues exhibit scarcely any appreciable alteration; or, on the other hand, in which one or more abscesses exist within the brain, while the dura mater appears healthy. Besides these cases of demonstrable secondary disease resulting from inflammation within the ear, instances occur in which death takes place with symptoms of cerebral affection, but in which no lesion whatever is found except within the tympanum.

The early symptoms of implication of the brain are rigors, often at first resembling attacks of ague (so that they have

been treated with quinine); and pain in the head, gradually becoming intolerably severe. This pain for the most part extends over the back of the neck, and it is greatly increased by motion. Delirium, impairment of consciousness, of speech, or of muscular power may ensue, and death follows, the pain generally being intense until the last. The sudden cessation of a chronic discharge from the meatus, accompanied by pain and fever, frequently marks the onset, or at least the threatening of an internal inflammation.

The symptoms, however, are not always of this acute character. As in other forms of abscess within the brain, there may exist for a considerable period scarcely any indications of the serious mischief that has taken place. Treatment, in this affection, is of avail to save life only in the earliest stages. When suppuration is established within the brain, and there exists a diseased bone in its immediate vicinity acting as a constant source of irritation, it is probably vain to hope to do more than alleviate the sufferings of the patient. The first and main indication in all cases is to obtain and preserve a perfectly free exit for matter. A case is reported by Dr. Gull, in which, though it issued fatally, a decided mitigation of the symptoms followed a discharge of matter through the nose; and an indication is thus afforded of the surgeon's chief task in every instance of this affection. Perforation of the membrana tympani, if it be entire; or its incision, if by adhesion to the promontory or otherwise it act the part of a valve; or trephining of the mastoid process, should be had recourse to, and promptly if necessary, to avert the retention of pus. In some cases polypi seem to obstruct the meatus; and then their removal becomes a matter of the utmost importance. A case is related by Bonafond, in which the crushing of a polypus gave exit to a large quantity of matter, with immediate relief to the gravest cerebral symptoms, and others have occurred in my own experience.

When inflammation extends from the ear to the lateral sinus, it proves fatal by secondary disease of the lungs, which become affected with lobular pneumonia and pleurisy; pneumo-thorax also, and sloughing of the lung, frequently occur. The symptoms are rigors, with sweats, fever, pain in the head and back of the neck, followed by stethoscopic indications of pleurisy; vomiting is often present. Tenderness and swelling may generally be found in the course of the jugular vein. On examina-

tion after death the portion of the mastoid cells, forming the floor of the lateral sinus, is carious to a greater or less extent, and that vessel contains a disorganised clot mixed with pus.

Although when these affections of the brain or lateral sinus are once established, the surgeon is powerless to stay their course, yet many cases occur in which symptoms of the most threatening character may be entirely removed by care. In these patients either the membrana tympani has been perforated and the mucous membrane of the tympanum inflamed, for a long time, a purulent discharge from the meatus being either constant or occurring at intervals; or, without rupture of the membrana tympani, there is a chronic inflammation of the meatus attended with discharge. During a cold, or from general ill-health, or from a blow, or even without ascertainable cause, the symptoms become aggravated, perhaps the discharge suddenly ceases; pain arises in the ear, extends over the side of the head, and is greatly increased by motion; giddiness may follow, with inability to stoop; fever is sometimes, but not always, present, and there may even be delirium; or slight attacks of the kind may recur at intervals and pass off. In these cases an entire abstinence from work, or any kind of excitement, must be enjoined; and, except in the mildest forms of the disease, the patient should be confined to bed. Leeches should be freely applied around and beneath the ear, and by fomentations and poultices the external discharge, if it have ceased, should be encouraged to return. The meatus may also be syringed, very gently so as to avoid giving pain, with water as warm as it can be borne. After the leeches counter-irritation should be employed; and a seton may be worn at the back of the neck until every symptom of cerebral irritation has disappeared. Purgative and alterative medicines may be administered, according to the judgment of the surgeon; but the latter demand caution. The injurious effect of mercury, when once suppurative action has commenced within the brain, is well known. If there be any puffiness or tenderness over the mastoid process, an incision down to the bone in that region should not be omitted; and any obstruction to the escape of matter should be thoroughly removed. Under these means symptoms of a very serious aspect will often entirely disappear; but great perseverance and prolonged caution are required. Frequently an incision of the membrane and washing out of the tympanum, as before described, will be found the needful remedy.

Another fatal consequence of disease of the ear is hæmorrhage. This occurs from ulceration of the coats of the adjacent vessels. Sir W. Wilde relates two cases, following scarlatina, in one of which the lateral sinus was found ulcerated. One case I have seen in a man of middle age, in whom severe pain in the ear was followed by repeated attacks of bleeding from the meatus. The patient sank, apparently exhausted by loss of blood; and on examination there was found caries of the tympanic walls, causing ulceration of the coats of the carotid artery.

VIII. MALIGNANT DISEASE OF THE EAR.

This is an affection occasionally met with, though it is not frequent. It commences in the deeply-seated parts of the organ; and a large part of the temporal bone and of the adjacent portions of the skull may be destroyed before life succumbs. The affection calls for no special remark, except that, as before observed, it is at some stages liable to be mistaken for polypus. The only case in which real difficulty would be likely to arise in the diagnosis, might be that of a polypus causing irritation of the brain by preventing the escape of matter; and here the history, and the difference of the symptoms in the two cases, could hardly fail to give the necessary guidance.

JAMES HINTON.

DISEASES OF THE ABSORBENT SYSTEM.

THE vessels and the glands of the Absorbent System are closely associated in their diseases, and cannot be conveniently or advantageously studied apart from one another. In the following essay, therefore, a separate notice of either part of the system will be taken only when some special facts of pathology or of treatment render it necessary.

Wounds of lymphatics.—Although some of these vessels cannot fail to be injured in every considerable wound, they are rarely noticed. A little lymph doubtless issues from them, but it is mixed with the more copious and more important outflow of blood, or with the subsequent oozing of interstitial fluids from the divided tissues. The wounded lymphatic tubes may be sealed by the common coagulum of blood; it is probable, however, that the lymph also by its own consolidation contributes to this effect.

‘Dr. Monro inflicted a wound on the receptaculum chyli of a pig, which was cured in a very short time; and in the mean while the effusion of the lymph was prevented by its coagulation.’ The exceptions to this rule, and to the repair of wounded lymphatics by the ordinary processes of healing, are so few and rare, that the following instances of failure may be mentioned.

‘A case of this sort I saw in a butcher, who, by letting his knife fall upon his shin, cut some of the large lymphatic vessels which pass over the tibia. From this wound there flowed a considerable quantity of clear lymph, which, being confined by the dressings, jellied; and then, at first sight, appeared like a whitish fungus, but being loose could be removed with a spatula. My patient was cured by tight pressure, and lint dipped in a solution of vitriol.’ *

A. Mouro, after removing a tumour from the arm, found the wound heal and contract ‘very fast, till a yellowish-white substance rose up from a small peduncle, at the part where the under part of the cephalic vein had been cut through. From this substance such a quantity of lymph oozed out from imper-

* Hewson, Sydenham Society’s edition, by Gulliver, p. 198.

ceptible orifices that the dressings were every day wet. I cut and eroded this substance away several times; but it quickly grew again, and the drilling of lymph became worse and worse, so that in a very little time it dropped so fast that I could have gathered a spoonful of it in a very short time. What cured it at last was, eating the fungus stuff and a little of the wound about with powder of Roman vitriol, and dressing the eschar with alcohol, which kept it from separating two weeks, in which time the orifices of the small pipes were soldered.*

Besides these openings of lymphatics by injuries, there sometimes occurs an escape of lymph from vessels opened by disease. Dr. H. Vandyke Carter, of the Bombay Medical College, met with three cases in which he had reason to think that chyle escaped by leakage or rupture from lacteal absorbent vessels. Alternately with this cutaneous leakage of chyle, a similar fluid passed in the urine, and Dr. Carter concluded that the disease known as 'chylous urine' is not a functional error of the renal or digestive organs, but an accidental admixture of chyle with urine by the rupture of a lacteal vessel, concurring with a breach of the mucous surface in some part of the urinary tract. The patients were Hindoos, in whom great but varying swelling took place in the scrotum and groin. In one of the cases a fluid resembling chyle sometimes issued, and after food copiously, from a spontaneously formed and very minute opening in the skin of the thigh.† In March 1869, Dr. Day communicated to the Clinical Society of London a case which closely resembled those related by Dr. Carter. The right lower extremity of a boy began to enlarge at two and a half years of age, and when he was seven, the whole limb was thickened, the penis and scrotum swollen with distended lymphatics, and chylous fluid escaped from minute vesicles and openings at the frænum and on the scrotum, as well as on the lower extremity itself. On a particular examination it appeared that the limb was not merely infiltrated with chyle, but was also overgrown, the bones and muscles participating no less than the skin and cellular tissue in the overgrowth. The reporting committee expressed an opinion that this hypertrophy of the limb was intimately connected with the distended state of the lymphatics, and they referred to four other cases in which lymphorrhagia with dilated lymphatics was associated with hypertrophy of the affected part, as well as to researches of Virchow upon hypertrophy of the tongue, which show that in that disease the muscular overgrowth is also of lymphatic origin.‡

Inflammation of lymphatics — Adenitis, Angioleucitis. — In most instances of inflammation in the absorbent system, the vessels and the glands are both involved; the glands are rarely, the lymphatic vessels almost never, attacked alone. Many cases of inflammation of glands (*adenitis*) are regarded as spontaneous, or as the result of the direct influence of cold, until a careful inquiry shows them to be dependent on a prior irritation of the afferent lymphatic vessels (*angioleucitis*). It is by no means unlikely, therefore, that some inflammations, which are now considered to be instances of primary adenitis, may yet be found

* *Medical Essays*, Edinburgh, vol. v. art. 27.

† *Medico-Chirurgical Transactions*, vol. xlv. p. 189.

‡ *Clin. Soc. Trans.* vol. ii. p. 104.

to be secondary to some hitherto undiscovered primary cause of the same kind.

Inflammation of the lymphatics occurs in many parts of the body. Traces of it are sometimes discovered in the interior of the trunk, after death, by the various changes it has produced; by serum or pus; by thickening, opacity, or accumulated concretions in or about the lymphatic vessels. But it is hardly ever actually seen except in connection with the skin or an ulcerated surface.

The disease, as it thus comes under the observation of surgeons, is usually an acute inflammation, originating in some previously irritated or inflamed tissue, extending in long narrow lines in the course of the absorbent vessels, and involving the nearest gland. It is often attended with heat and a transient redness of the adjoining skin, with considerable pain, and with rather severe symptomatic fever; and it may issue in an effusion of serum and lymph, in suppuration, and in blood-poisoning.

Most inflammations of the absorbents start from an open wound. Such a wound may be in almost any condition, and of any form. It may be punctured, cut, torn, blistered, torpid, healing, scabbed. The mere state of the wound does not determine the occurrence of the inflammation. It may, indeed, manifest itself after the absorption of a poison without a wound, as when red lines cover the penis from recently contracted gonorrhœa; even breathing the exhalations of corrupting animal matter may occasion it, although the wound from which the angeioleucitis afterwards spreads be at the time sedulously covered; but there is in most cases ample evidence of direct infection of the wound. The morbid matter may be some local inflammatory product, as when the inflammation follows the prolonged friction of excoriated skin, or the confinement of the secretions of a sore by a hard scab. More commonly, however, some irritating or poisonous material is known to have been applied to the wound from without; or some gaseous poison, though not known, may be the real, as it is sometimes the ascertained cause of the inflammation. My colleague, Dr. Greenhow, describes inflammation of the absorbents of the arm as succeeding a diphtheritic exudation beneath a vesicle of the hand.* He has seen the same occurrence in the neck, connected

* Greenhow, *On Diphtheria*, p. 196.

with diphtheria of the throat, and fatal. Once only, and in a very rapid case, I have known an acute inflammation of the lymphatics, with redness of the skin, to accompany and indicate the first infection of the glands with secondary cancer (see p. 346).

The course of the inflammation is commonly pointed out by a linear redness of the skin, which is often many times broader than the vessel beneath. The lines follow the direction of the absorbents, not of the veins; and in the arm they may cease at the wrist, or the elbow, or at any intermediate part at which the inflamed lymphatic vessels end in a gland, or lose relation with the skin; but they never pass the armpit. The tenderness along such inflamed tracks is excessive, and it commonly extends to the next absorbent gland, whether the redness reach so far or not. The rapidity with which such lines are sometimes formed is remarkable, and is only equalled by the instantaneous ophthalmia which occurs when a foreign body enters the eye.

‘Mr. Hunter saw a case, in which the skin being pricked by a needle which had never been used before or touched any infectious or irritating substance, occasioned the lymphatics of the arm to inflame, and show themselves in the form of red lines, running towards the axilla; in consequence of this, some one of the glands there also inflamed and swelled, the patient had rigors and sickness, and all this in the space of a few minutes.’ *

Such extreme rapidity in the development of inflammation is unquestionably rare, although Cruikshank states that he has seen other similar cases in the instance of the absorbents. The red lines, indeed, are not invariably formed; and this may be readily understood, if they be regarded as occurring only when the inflammation is widely spread, and therefore rather intense.

The inflammatory action, as indicated chiefly by these red lines, sometimes extends slowly, and as it were continuously, by the tissue of the lymphatic vessels; far more commonly it attacks them simultaneously in nearly their entire length, and appears to be consequent on their becoming filled with fluid of an irritating quality. That the latter is the mode of origin is further likely from the fact, that the disease travels only upward from the wound to the next gland, and not in the opposite direction. It will extend, for instance, from a wound on a knuckle to the axilla, but not along the finger; from the heel to the ham, but not to the foot. There are some apparent

* Cruikshank, *On the Absorbents*, p. 76.

exceptions to this rule, but they are probably to be explained by the continued absorption of noxious matter at the wound, and its accumulation below some point of obstruction in the track of the lymphatic vessels.

A woman came under my care with a series of eight abscesses between her finger and armpit. The highest was on the inner and posterior part of the upper arm; the lowest was on the back of the hand. They differed in size by a regular gradation from the highest, which equalled a walnut, to the lowest, which was no bigger than a cherry, and was the least mature as well as the smallest of all. There was no suppuration in the axilla. They were all punctured, and got well; yet inflammation and œdema, if not suppuration, eventually took place at the finger. It was clear that the highest abscess, being the largest, was the first formed; and that each of the others successively arose next after the one above it. The only cause which appears assignable for the later abscesses is, that fresh matter arriving from the finger accumulated below the preceding ones, until at last, by the inflammatory action in the finger, the source of the irritation was got rid of. Wiseman describes a similar inflammation, which apparently descended along the absorbents of the thigh and leg.* A man came under my care for suppuration spreading from the axilla and reaching down the side of the trunk to the loin. Vast quantities of matter were evacuated by dependent openings, and the suppuration was restrained by appropriate bandaging, injections, medicines, and food. As the discharge subsided, the hand began to suppurate in a spot from which inflammation, spreading by the absorbents, appeared to have first occasioned the abscess in the axilla. The man recovered.

The inflammation ceases at the nearest gland. This is a fact abundantly exemplified both in the simple and the specific inflammation of absorbents. The known situations of the superficial glands are those towards which inflamed absorbents may be traced, and at which their inflammation culminates to its highest degree of severity, and is almost invariably extinguished. The gland appears to arrest the free progress of the acrid lymph, itself becoming inflamed. Sometimes the current of morbid lymph through it is completely stopped; at other times it gives passage to the lymph, or itself supplies morbid material to the higher absorbents and the circulating blood. Even in that case, however, the higher glands do not inflame or suppurate. Did they do so, we should commonly see abdominal abscesses, peritonitis, &c., in primary syphilis, and inflammation in the neck combined with traumatic suppuration in the armpit. The inflammation of a gland, which is excited under these circumstances, may vary from a slight increase in its size and firmness, with some tenderness, to a degree of severity which

* *Chir. Treat.* 1692, p. 48.

issues in extensive suppuration. The gland in the former case may be felt rolling in the tissues, almost as readily as in health, and its tender and swollen state outlasts the inflammation of the afferent lymphatic vessels by a few days. It may, however, enlarge to twice or thrice its natural size, and continue swollen and tender for two or more weeks. This is especially noticeable in the case of a gland near the femoral ring; the tenderness, tension, even surface, and position of which sometimes cause it, when recently inflamed, to be mistaken for a strangulated hernia, especially if at first there should concur with its inflammation some nausea and constipation. Or, further, the gland may suppurate. This event may not ensue until a week or more after the inflammation of the lymphatic vessels has passed away. It is sometimes indicated by a renewal or increase of the local pain, and by rigors and other constitutional symptoms. But not at all unfrequently suppuration occurs in a gland without any local symptoms which attract notice. The first pain attending the inflammation having subsided, a patient may be unconscious of any disease in his armpit, while matter to the extent of half a pint or more may be collecting there and behind the pectoral muscle. Suppuration is rarely limited to the area of the gland. The suppurating structure is rather the loose areolar and adipose tissue in which the gland is embedded, and which here, as elsewhere, is observed to suppurate with a less degree of inflammation than that which already exists, without exciting suppuration, in the inflamed organ. Abscesses connected with inflamed glands may therefore reach any size which their position allows; they are, for instance, prone to be larger in the loose tissue and spacious area of the axilla than in any other region occupied by superficial glands. The matter discharged from them is thick and well formed; and after it and any slough which may have been produced by the intensity of the inflammation have been evacuated, the cavity closes. Usually an abscess in the armpit or groin soon heals, but sometimes when it has burrowed far beneath the fascia, and in the popliteal space, the cure is slow.

Inflammation and suppuration of the glands appear to be eliminative as regards the afferent lymphatics and the injured distal parts, and protective as regards the circulating blood. During the continuance of suppuration in the axilla, the activity of inflammation in the distal parts subsides, as gonorrhœa is often temporarily suspended so long as a bubo is forming or

freely discharging.* On the other hand, the poison which has reached a gland by way of the lymphatics does not pass beyond it. When, however, a cutaneous pustular eruption comes out on the trunk, or severe constitutional symptoms, like those of pyæmia, arise, it is clear that the morbid poison is not limited by the gland in the manner supposed. Of the various hypotheses by which these occurrences may be explained, those seem most consistent with the anatomy and the other diseases of the absorbent system, which assign the pustular eruption to the anastomosis of minute cutaneous lymphatics, and the infection of the blood to the glandular suppuration itself. In the former case, the poisonous matter which is held back by the suppuration traverses the collateral channels, and produces pustules wherever it filters over the vast area of skin subordinate to the obstructed glands. In the second case, the matter from the gland itself is assumed to find a passage along the efferent lymph-tubes into the blood.

The constitutional symptoms attending an attack of acute angioleucitis are sometimes severe. Rigors, nausea and vomiting, heat of skin, thirst, dryness and coating of the tongue, with constipation, sleeplessness, and considerable nervous agitation, a quick bounding pulse, and a feeling of languor, are usually the severest accompaniments of the disease. If the fever be typhoid, if there be profuse foetid sweats, severe muscular pains, high excitement, a dry burning heat of skin, and marked delirium, the poison is no longer limited within the lymphatic channels, but has infiltrated the cellular tissues, and has tainted the blood.† As the inflammation subsides, and local suppuration, a cutaneous eruption, or foetid discharges from the bowels, come on, the general symptoms become those of exhaustion.

The cases depicted in the foregoing description are those of considerable but of ordinary severity. There is much variety in this respect, however, in different cases. There may be a mere passing soreness, with some enlargement and hardening of a gland, whilst the intermediate lymphatics between the

* 'Ubi pestis minus sævo morsu lacescit, in molliores decumbit glandulas, quæ ad corporis superficiem prominent; quales sunt inguinæles, axillares, &c. Si convalescere datur ægrotanti, tumores ii, uti in variolis, legitimam nanciscuntur suppurationem, morboque naturam hac via exonerant.' (Mead, *de Curatione Pestis*.)

† See ERYSIPELAS, ANIMAL POISONS.

wound and the gland have either not inflamed or been so little irritated that no pain or inconvenience had been felt in them. A hard cord may be felt beneath the skin, leading to a tender swollen gland, but there may have been no red lines, and there may be no suppuration. There is sometimes an axillary abscess without the previous occurrence of red lines, and the latter may form without occasioning any axillary tenderness. Sometimes the track of the absorbents is tender for a day or more before the red lines appear, but more commonly they are amongst the earlier symptoms of the inflammation. In one case I have seen red lines appear twice between the wound and the armpit. No suppuration took place in the inflamed gland, but a pustular eruption over the trunk seemed to show that some poison which had passed the gland was being eliminated by the skin. In another case the absorbents inflamed without occasioning the linear redness on the skin, and three abscesses formed in the axilla. There was in this case no cutaneous eruption. When suppuration occurs, it most commonly does so only in the gland; but it may take place in the absorbent track, without involving the gland, or may affect both the vessels and the glands. In the later progress of the severer cases additional symptoms and pathological changes may result from particular constitutional tendencies of the patient. Thus I have known inflammation of the absorbents of the arm terminate in fatal acute cedema of the tongue, the absorbents being infiltrated from the thumb to the submaxillary gland.

Simple traumatic inflammations of the absorbents prevail in particular localities. They are very much more common in the arm and axilla than in any other parts of the body. A similar observation has been made respecting plague, and the reason in both cases appears evident. The hand, from which these inflammations originate, is at once more liable to injury, and, except the face, more exposed than the rest of the surface. Glandular suppurations in the mesenteric, lumbar, and bronchial glands are as small as they are rare, and only some of the cases of iliac and pelvic abscesses following upon parturition are to be compared in extent with those in the armpit. In one situation glandular suppuration calls for an especial notice, viz. at the lower part of the left side of the neck. A severe and deeply seated acute abscess is apt to form in that situation, and, as it is bound down by the fasciæ and platysma of the region, it may continue long without finding an outlet. It

occasions great swelling, œdema, tension, and pain. The root of the neck is much raised by the swelling, and the clavicle hidden. In all the cases which I have seen, the abscess was on the left side of the neck, involving the whole region of the cervical part of the thoracic duct, and not extending into the axilla. The cause of these great and severe suppurations is sometimes obscure, and they may not always originate in disease of the lymphatics; but sometimes such a mode of origin does appear, and in one of my cases an enlarged tender gland was described as having been first felt. It should also be remembered from how many parts lymphatics converge towards the left side of the neck. This is the only situation in which I have known an acute and severe suppuration subside without the external discharge of the pus.

Inflammation of the lymphatic glands, *adenitis*, sometimes occurs alone, *i.e.* without any previous perceptible inflammation of the afferent vessels. It does so after some of the fevers of childhood. The higher cervical glands are then very liable to swell and become painful. Being in the neighbourhood of the lower jaw, tongue, and pharynx, all movements of these parts are restrained, and a good deal of suffering attends mastication and swallowing. Such cases of adenitis follow scarlatina, and are sufficiently explained by the state of the throat. These cases are not to be confounded with those of true cynanche parotidea. An absorbent gland in the centre of the parotid may inflame as lymphatics inflame elsewhere, but its disease does not produce the characteristic, contagious, and metastatic affection commonly known by the name of mumps.

Treatment of inflamed absorbents.—Many of the ordinary duties of life expose persons to this painful affection; and it often arises in circumstances to which busy manual labourers pay no attention. Soaking fresh cuts in Burnett's fluid, or the application of collodion upon a small wound or puncture, or of court-plaster upon a longer wound, might avert many of the attacks of inflamed absorbents.* When patients with wounds of any kind are under medical advice, the common precautions of cleansing the wound, securing the proper action of the purifying organs, and avoiding unhealthy diet, air, and occupations,

* The practice of smearing the hands with glycerine or oil before touching noxious fluids is found to prevent the mischiefs which might arise from absorption, and is of great value at post-mortem examinations.

are enough to prevent such attacks. Upon the occurrence or threatening of an inflammation of the absorbent vessels, the wound may be soaked in undiluted sulphurous acid, a measure which I have found to arrest suppuration near the finger-nail, produced by an animal poison, and already beginning to infect the lymphatics. The wound should in all cases be thoroughly cleansed. It should be opened, put under a stream of water, syringed, or soaked in a thoroughly hot bath, as may best suit its form and condition. If recent, or punctured, it should be sucked, and then touched throughout with a stick or pencil of nitrate of silver. If flabby, it should be stimulated with a suitable mineral lotion. If foetid, it should be wrapped in solutions of Condyl's or Burnett's fluid, or in chlorinated lotions. If sloughy, it should be covered with Peruvian balsam and a poultice of linseed meal, charcoal, or beer-grounds. Heat is in all these cases grateful to the patient, and if often changed, in order to secure the cleansing of the wound, a poultice will generally be found the best local application.

The lymphatics themselves are best treated by the nitrate of silver. It should be wiped a few times on the moistened skin along the red or tender lines. Care should be taken not to apply it too freely, as the subcutaneous inflammation can be as effectually moderated by blackening the skin as by blistering it. After soaking and applying caustic, the surgeon may wrap the limb in cotton wool, and enjoin complete rest.

The glands in the early stage may not have shared the inflammation, yet the nitrate of silver may be applied over them also, and the use of it should in all cases be carried higher than the tenderness and redness of the surface. The removal of all further irritation from the wound, and moderating the inflammation of the lymphatic vessels, will in most, but not all, cases secure the patient from suppuration in and near the glands. If further means appear requisite for this end, they may be found in leeching, and the application of ice or a cooling lotion to the surface. I have not, however, found cold adapted to arrest threatened suppuration in glands. Heat is commonly more grateful to the patient than cold in such cases. It may be employed in a bath or in the form of steam. The latter may be directed from the spout of a kettle against the tense and painful part by means of a paper tube. If the inflammation continue, mercurial ointment is also useful; it should be laid not only over the gland, but along the track of the previous

lymphatic inflammation, which has already indicated the natural channel for absorbed remedies to reach the inflamed gland. It may be observed, however, that in not a few instances, when once the glands have inflamed, no treatment averts suppuration, and special attention must always be directed to them for a week or two after the first inflammation, in consequence of the occasionally insidious progress of abscess after adenitis. When acute glandular abscess is advancing to the surface, and occasioning much pain, it should be opened. But if there be any reason against this treatment, much relief to the suffering, and some acceleration of the pointing, are obtained by leeches. From one to three leeches are quite enough for this purpose; a larger number would have the effect of retarding and diffusing the suppuration. In like manner the slow progress of a chronic abscess of glands may sometimes be quickened by the application of a small blister upon the prominent part of the swelling.

The treatment in the lymphatic inflammations of convalescents is chiefly that which will relieve the pain and guard against the somewhat rare event of suppuration. Steam, followed by an application of cotton wool, ordinarily serves this purpose, and pure air, without draught, is also of much importance.

Hypertrophy and atrophy of glands.—One of the first facts observed in studying the lymphatic system is, that in disease, and still more in health, its condition varies with that of the tissues from which its vessels spring. So far as age defines the activity of growth and nutrition, the glands vary with it. They are proportionally larger in children than in adults, and in these than in persons advanced in life. But with premature emaciation of other tissues, glands also waste before their time, and they have been found larger in a well-nourished woman at ninety years of age than in one who at fifty had died exhausted by chronic disease.* In wiry, slender people the glands are small and firm; they are succulent and large in persons characterised by softness of fibre, a thin fair skin, and some embonpoint. Even in the same body the lymphatics differ from one another according to the tissues with which they are associated, the structure or functional activity of the primary organ

* Gulliver's *Hewson*, Sydenham Society's edition.

entailing some corresponding variation in the texture, the size, and even the number of the subordinate lymphatics. There is, for instance, less glandular structure in the course of the absorbents of one of the lower extremities than of one of the lungs, great as is the difference in the bulk of those parts. The largest of all the absorbent vessels are those found in connection with the uterus at the period of parturition. And as in size and number, so are there differences in the texture of various lymphatics. 'The glands of the thigh or arm will sustain a large column of mercury without bursting; whilst the glands on the mesentery, or on the lumbar vertebræ, easily burst.' For 'these last resemble the viscera of the abdomen and thorax, whose texture is much more delicate and tender than that of the external muscles.'*

The transition is imperceptible from an hypertrophy or enlargement of glands, which corresponds with the state of the tissues, to one which is strictly morbid; and in practice it is scarcely to be defined. A general fulness of all the glands concurs in some persons with rickets, a large brain, and a hypertrophied thyroid gland. In other cases, the large succulent glands, which are met with in children of soft loose fibre, seem readily to receive the yellow deposit of actual disease. There is also a class of chronic enlargements of the glands, which are occasioned by no traceable inflammation of the afferent lymphatics, and are attended by no pain, and but rare liability to suppuration. They have been described by Dr. Hodgkin in the *Medico-Chirurgical Transactions*, vol. xvii. The specimens preserved in Guy's Hospital Museum are of very large size, one gland alone being three inches or more in length. They are smooth, uninflamed, and entirely free from scrofulous deposit. They are said to have been of semi-cartilaginous hardness, and, on section, pale, uniform, non-vascular, and slightly translucent. They were observed almost universally throughout the body, and accompanied with an enlargement of similar appearance in the spleen. They occurred both in children and in middle life, and they proved fatal by anæmia and exhaustion. Their microscopic character is that of glandular tissue, with excess of the nuclear element. (See the drawing of *lymphoma* in vol. i. plate x. fig. 10.) Sometimes a single gland is thus enlarged, and its texture is so loose as almost to fluctuate. Such glands, as well as

* Cruikshank, *On the Absorbents*, p. 71.

those which are plainly strumous, may by mere bulk occasion great inconvenience when lying near ducts, vessels, and nerves. Death has been attributed to their encroachment on the bronchi. I have seen a case thus fatal at seven years of age, one side of the neck being greatly swollen with clustered glands of large size, which extended into the mediastina, and the lung and chest on the same side being diminished. Their presence in the pelvis is said to be capable of interfering with parturition, and when pressing on the trachea they have occasioned so much distress that the subcutaneous division of the sterno-mastoid has been thought advisable to relieve the breathing.*

When these cases are excepted, and those which are referred to in other parts of this essay, there are few slow enlargements of the glands left which can be assigned to mere chronic inflammation. Some such cases, however, inasmuch as they yield to a mild mercurial course, are assumed to be of that nature. The case had need be very clear which could admit of such treatment; but the fact of its occurrence justifies the treatment in cases which are unmarked by constitutional disease, or which do not yield to the milder measures recommended for the treatment of scrofula. The mercury should be prescribed in small doses, and be combined with some tonic. Quinine and calomel, the bichloride of mercury in decoction of bark, the biniodide of mercury in the form of a pill, and calumba, cascarilla, quassia, or sarsaparilla—any such combinations may be adopted. Dr. Hodgkin was disposed to rely on the use of liquor potassæ in the management of the cases which he described, but he had no opportunity of testing the remedy. The state of the glands in cases of rickets rarely rises into importance as compared with the other disease. When it does so, it is chiefly on account of suppuration taking place in them, with every indication of a strumous character. Local treatment may go on at the same time; ointments or washes of lead, iodine, opium, or of combinations of these remedies, being continuously applied. Blisters are to be avoided in glandular inflammations. They necessarily irritate the lymphatic vessels of the skin, and tend to aggravate, rather than moderate, an existing inflammation. A leathern plaster left constantly on the surface is more effective in reducing the swelling, and it may be medicated in any

* Gross, *Surgery*.

manner suitable to the case; the various emplastra of the Pharmacopœia affording choice enough for that purpose.

Strumous disease in the lymphatics having been selected to illustrate the subject of SCROFULA, it will not be necessary to repeat in this place so much of the description of the glandular disease as was required for the general article on that subject (vol. i. p. 367). It may be observed that the new use of the word struma by Professor Virchow, to signify bronchocele, suprarenal, and pituitary disease, is not here adopted.

Strumous disease may occur in glands with the inflammation which often succeeds the eruptive fevers of childhood and youth. Measles, varicella, scarlatina, &c., are not uncommonly followed by an enlargement of the cervical glands, which may become chronic, and assume the characters and course of struma. Scrofula may also originate in glands, upon some irritation or disease of the tissue or organ with which they are connected. It appears to be produced in the ordinary way of inflammation of lymphatics, but to be modified by the state of the constitution in which it occurs. Sometimes an injury, far more frequently a slight chronic ailment in the skin, occasions an enlargement of a gland or glands, the deposition of strumous matter in it, and subsequent characteristic softening, which can hardly be described as suppuration. Many enlargements of the cervical glands may thus be traced to eruptions on the scalp; some to inflammation or suppuration of the ear; others to the irritation of decayed teeth. Again, there are affections of the glands with struma, traceable to primary disease of the same nature in the organ to which the glands are subordinate. Scrofula is thus repeated, after the manner of cancer, in the spermatic and lumbar glands from tubercle in the testis; and, like cancer, too, it will increase in the absorbents, and prove fatal after the extirpation of the organ which was primarily diseased. Bronchial glands are often tuberculous in correspondence with the lungs; a gland over the masseter with the blear eye, or strumous lippitudo, &c.

But there are not wanting cases in which a primary occasion for the disease in the glands cannot be discovered, and in which the cause may be some chronic and undefined fault in the nutrition of the tissues. For whilst, in some instances, only the bronchial glands are tuberculous, there are others in which they only are exempt from the disease. Some patients have only an

enlargement of the lacteal glands, the lymphatics being everywhere natural; in others the disease is entirely limited to the general absorbents, those of the bowels being healthy. Some patients, again, have a universal disease of the glands. In these instances, the extensive disease can only be supposed to arise from a general cause, as distinguished from a local irritation.

The diagnosis of strumous disease of glands is rarely difficult. In an early stage of their slow enlargement they may in the axilla imitate the firm nodular glands which are becoming cancerous, and for some time be difficult to distinguish in women who, scrofulous in youth, are at the age liable to mammary cancer. But the progress of the disease clears up the doubt. The large, clustered, movable, tuberos masses of strumous glands in the neck, axilla, or groin, can be always recognised to be glandular, and there is but one other disease which is liable to be confounded with them. Medullary cancer sometimes grows in many glands and to a large size, and forms a cluster in the manner of those of scrofulous nature. But glandular medullary cancer without a distinctive recognisable primary growth is extremely rare, and in the presence of such a growth the difficulty of diagnosis could not occur. In the few instances in which cancer does happen in glands alone, it may at first be but uncertainly distinguished from strumous disease, by its more rapid growth, its less isolable and softer lobes, its elasticity, and sometimes by its electric pain. The late progress of the cancer to vast size, livid elastic protuberances, and fungous bleeding openings, are plainly distinct from the slow enlargement, the shallow suppurations, and the flaky puriform discharges of the scrofulous tumour. But little assistance can be derived from the age of the patient, as the majority, both of strumous and medullary diseases of glands, occur before puberty. A single strumous gland is liable to be confounded with a hydatid or cyst, especially when it has suppured, and has remained long encysted. The distinction can only be drawn by the history of the case, the appearance of the patient, and dexterous discrimination of the shape of the tumour or of some remaining portion of the gland.

The *suppuration* of strumous glands, though commonly slow and immature, is occasionally acute, copious, and attended with rapid emaciation and weakening of the patient. This seems to be particularly the case with strumous glandular abscesses in the groin, which sometimes equal the largest orange, and dis-

charge as much as three-quarters of a pint of muddy, ill-formed pus, mixed with large quantities of yellow scrofulous flakes. Even when opened comparatively early, or while yet forming, these acute strumous abscesses are attended with hectic, and a general debility not less severe than that which accompanies the softening of tubercle in the lung.

Far more commonly the abscesses connected with scrofulous glands are remarkable for their slow progress, the occasional variations in their condition, their rather frequent spontaneous removal, their feeble efforts at repair, their burrowing, and sometimes for the copious and even fatal hæmorrhage which they occasion. They appear to be formed outside the gland, and to have therefore one part of their surface, viz. the gland, in a state of disease. The matter in them is not pure pus, at once the effect and cause of vigorous inflammation in the tissues around it, but yellow tuberculous lymph, and a serum so thin and slightly cloudy as to suggest that it may be but lymph from lymph-tubes and cavities in the gland. Sometimes the abscess becomes flaccid, from a part of its contents being absorbed, or removed by the way of the lymphatic vessels; and sometimes the fluid part entirely disappears, leaving only the solid yellow material behind to shrink, and after a long period to become cretaceous. A strumous abscess rarely points; it generally widely undermines and destroys the healthy skin which covers it; it burrows also among the areolar tissues, which, as has been said, do not resent its encroachment, or enclose it by a compact dam of lymph. The opening of such an abscess, therefore, is but the opening of one portion of a sinuous canal. In its deeper parts it may extend to the vicinity of large blood-vessels, and disastrous results may ensue. The internal jugular vein is sometimes obliterated and contracted near such an abscess; two or three inches of it may be entirely removed, and its upper and lower orifices plugged with lymph. Arteries in such circumstances, on the contrary, may ulcerate: and not a few cases are on record in which large quantities of arterial blood have poured from strumous ulcers, involving the internal carotid. Mr. Syme met with such a case, in which the hæmorrhage issued repeatedly, and even after the ligature of the trunk-vessel, from an abscess beneath the ear, but was finally stopped. My colleague, Mr. De Morgan, tied the common carotid for profuse arterial hæmorrhage from the tonsil in a case of strumous disease of the higher cervical glands. The patient rapidly and

entirely recovered from phthisical as well as the local strumous symptoms under which he had been labouring.

The *treatment of scrofulous glands* is in great part constitutional. The disease being of slow growth, and based upon gradual impairment of the general nutrition, a rapid improvement is not to be expected, and the measures adopted must be continuously persevered in for a long period. When it is remembered, too, that in some instances external glandular has been observed to alternate with the far more perilous tubercular disease of the lungs, and that in very many cases the supervention of the latter disease upon the former is fatal, it will be seen that improvement of the health is rather to be desired than the mere removal of local disease. Good air, nutritious food, ample and cheerful exercise, act imperceptibly but continuously upon the system, and supply the best means of reducing, as the contrary influences do of originating, scrofula. If, therefore, the complete removal of the disease and its cause is to be accomplished, these advantages must not be supplied for a short time only: the citizen should take up his residence in the country, selecting high lands or the eastern sea-coast of our island, in the summer; and either returning to the comforts of town or to a warm locality for the winter. It is an error to prefer mild moist climates. Provided the chest be still sound, it is surprising to observe the rapid improvement of scrofulous sores and swellings, and the high standard of health and bodily vigour which is obtained by a temporary residence at Margate. Cases of phthisis are at all times injured there.

The medicinal management of strumous glands is amply described in the essay on SCROFULA, vol. i. pp. 373 et seq.

The acute suppurations of struma need early evacuation by the knife, as much as other abscesses; and in order to avoid the drain upon the patient's strength which they cause, they should be carefully syringed out and dressed with lotions of gallic, carbolic or sulphurous acid, with iodine, or with solutions of silver, copper, or zinc, and then accurately bandaged and compressed. Their discharges, in fact, must be lessened as much as is consistent with the necessary expulsion of their unorganisable contents and walls. The patient will require ample food and stimulants from the first.

In respect to the treatment of chronic strumous abscesses, little need be added to the general remarks made in the essays on ABSCESS and SCROFULA. It should not be forgotten that some

such collections of ill-formed pus, are reabsorbed. An abscess, advancing to the surface without actually pointing, may be opened and freely and repeatedly syringed out. The puncture may then be closed and the cavity compressed, with the hope of its walls cohering. This is most likely if at the same time the plan of Mr. De Morgan be carried out, and the pyogenic surface be destroyed with a solution of thirty or forty grains of chloride of zinc in an ounce of water, and then stripped off with the finger. When the abscess has widely undermined the integument, the attenuated skin is often incapable of recovery. It becomes livid, opens, and very slowly ulcerates. Its presence interferes with the free discharge of the matter, and prevents the cicatrization of the abscess. Very much time is saved and unsightliness spared by the application of caustic to the whole integument so thinned, as upon the separation of the slough the base of the abscess is freely exposed, and its margin is in a state to cicatrise. Some sinuses, which undermine the skin, need to be laid open by the knife in their whole extent or at suitable intervals by limited applications of caustic. The majority of such cases will then heal under pressure. Others will close if injected with iodide of starch, or if that substance be introduced into them by powdering it on a seton thread. In a few persons, however, perhaps including some malingerers, no surgical treatment whatever secures the closure of these burrowing fistulous ulcers. They may be slit open, cauterised, injected, pared along their edges and to their very extremities; yet they will burrow still. Nothing but fixing the nearest joint, a change of residence, or great improvement in the general health, proves successful. Massive and projecting strumous glands, the presence of which retards or prevents healing of the abscess, may be destroyed by piercing them with sharp sticks of caustic. Upon the expulsion of the slough, such sores become level, and may heal.

Lymphatics in syphilis.—The actions of the lymphatics when infected with syphilis supply an important part of the general doctrines of that disease, and have been amply described in Mr. Lee's essay (vol. i.).

Lymphatics in gonorrhœa.—The lymphatics in this disease sometimes share in the intensity of the local inflammation. The penis may be covered with red lines, and the inguinal

glands inflame and suppurate on one or on both sides. This whole subject will be found treated in the essay on GONORRHŒA.

Lymphatics in cancer.—For facts connected with cancer in the glands, reference may be made to the essay on that subject in vol. i. Some additional remarks bearing on diagnosis will be found in the section upon the state of the *glands in innocent diseases*.

An absorbent gland infected with cancer may contain the minutest speck of the disease. I have found under the microscope in epithelioma a single small spot of characteristic cells in a whole field of perfectly healthy glandular structures. But it often entirely ceases to be a gland at all. The whole structure is replaced by cancer. In certain situations the disease extends to all adjoining tissues, and involves and destroys all the glands of the region. Secondary cancers in the groin, for example, following primary disease of the penis or vulva, may thus exterminate all the inguinal lymphatic system, and, when they ulcerate, may give an outlet for a copious discharge of lymph. In such a case there may be not only considerable œdema of the foot and genital organs, due to the hindered circulation of the lymph, but a wasting also, and in one instance an almost complete conversion into fat of glands in the lumbar region, as if their function had been lessened or abolished by the isolation of the lower limb. Far more commonly the rule is observed that cancer reproduced in the lymphatics becomes diffused throughout the system.

Cancer of the lymphatic glands is rarely difficult to recognise. Some primary tumour claims the chief attention, and determines the nature of the secondary affection. When the glandular disease so far exceeds that of the primary tissue as to be first observed, it may be distinguished to be scirrhus, sometimes by the contracted shot-like tumours to which the glands are first reduced, sometimes by their being enlarged, sometimes by their being clustered together into an irregular tumour. The characteristic hardness of scirrhus is more commonly noticed in the first case, since, when scirrhus occupies but a part of a gland, the remainder of it may swell and cause the whole to feel comparatively soft; and when it occupies one or more entire glands and grows beyond them, the whole tumour is stony only so long as degenerative softening in it is delayed.

The distinctions of encephaloid cancer of glands are stated at

p. 341, and those of the epithelial form of the disease in vol. i. p. 572.

The first occurrence of cancer in a gland may take place quickly or late after the formation of the primary tumour. In some instances the secondary disease is even observed first; in others, the lymphatics escape infection altogether. Upon what these various facts depend is not known, but it is interesting to observe that they have their parallel in the pathological actions of the lymphatics after the insertion of a poison into the body. Sometimes they inflame with great rapidity, and sometimes they are not affected at all. Sometimes their inflammation is delayed, and in the case of the inoculation of small-pox it is not until the seventh day that the glands inflame. The advance of cancer to the glands, and its commencement in them, are almost invariably unnoticed; but in one case of primary and still un-ulcerated cancer of the hand, the absorbents were first affected with inflammation, red lines suddenly arising on the skin, and a gland enlarging, which soon assumed the character of cancer. The patient was a well-grown womanly girl of fourteen, and the disease of medullary nature, and extremely rapid in its progress.

When once established in a gland, cancer usually pursues its course like any other secondary tumour. It may attain a very moderate or a vast size; it may be stationary, or may wither; it may appear dependent or independent on the primary growth or on the growth of other tumours in the body. These facts are sufficiently stated in the article on CANCER. It may be added, that no cases of an universal tainting of the lymphatic system with cancer are observed, as is sometimes the case with tubercle. Cancer appears to travel along the absorbents in a manner which is explicable by the anatomical arrangements of those vessels, and not to affect the system as a whole.

The glands in innocent diseases.—Lymphatics appear to have no special relation to the functions of the several parts with which they are connected. Organs having only blood-vessels, and those provided also with an excretory duct, equally possess a system of absorbents. The glands may therefore be said to be appended to the tissues, as such, and may be expected to vary with those tissues in their condition. That they do thus vary within the limits of health has been already stated in the section

on *hypertrophy of glands* ; and the probability is that they are consecutively altered by every morbid variation in the condition of the tissues.

In practice, however, such morbid variations are not appreciable, unless they cause a change in the size, form, or density of the glands. So far as surgery is concerned, glands not appreciably affected pass for being healthy.

The importance of the question as to the state of the glands in various diseases is shown by the general fact already alleged as to their implication in cancer, in contrast with their relation to tumours which may be classed as not malignant. Although at the commencement of cancerous growths the glands are rarely affected, yet they are sometimes both early and most extensively diseased, and at some period before death they are almost always invaded. Even the bony substance of osteoid is reproduced in the glands. An affection of the lymphatics by any innocent tumour, on the contrary, in the same sense in which they are involved in cancer, is very rare, probably as rare as the case of glands unaffected in that disease. They may indeed be enlarged in connection with an innocent tumour, but it is because irritation of the skin or ulceration likewise exists. Such enlargement is a transient inflammatory swelling, not a reproduction of the primary disease in the gland, and is no more to be ascribed to the presence of the tumour than if none existed.

Reserving such cases, I may enumerate the following diseases in which no appreciable affection of the lymphatics is observed : all simple hypertrophies of any organ or part, and all tumours which present some likeness to the structure in which they are formed. Fibrous tumours of the uterus and prostate, therefore, mucous polypi, chronic mammary tumours, cutaneous thickenings and mollusca, adipose tumours, and exostoses, with other growths of the same character, are unattended by the development or repetition of the disease in the glands. If cysts should co-exist with malignant tumours, the glands may be affected with cancer ; but cysts, as such, and cysto-sarcoma, are never followed by corresponding disease of the lymphatics. This fact is observed in the ovary, the os uteri, the kidney, the subcutaneous structures, the spermatic cord, sometimes in colloid, and, what is of the greatest practical importance, always in the female breast.

My colleague Mr. De Morgan * had under his care a middle-aged woman, whose left breast was the seat of an enormous innocent tumour, and the right of a well-marked scirrhus growth. The former tumour, growing rapidly, and threatening the patient with speedy death, was removed, and was found to be mixed cystic and adenoid, copiously infiltrated with cells and nuclei. The right axillary glands were extensively cancerous; yet even with cancer thus existing in the body elsewhere, the glands in the left axilla were healthy.

Some tumours, composed of structures unlike the part in which they grow, are not attended by disease of the same kind in the glands. An enchondroma of the femur which I observed, though of vast size and fatal to life, was entirely limited to that bone. In the ischium also a cartilaginous tumour has been known to be unattended by lymphatic disease.† The same fact is commonly noticed in the enchondromata which grow in the fingers and the parotid region. Mr. Paget met with an exception to this rule of exemption of the lymphatics from secondary cartilaginous infection, in a case of enchondroma of the testis.

Tortuous large vessels in the cord were found to be filled with adherent fragments of cartilage, and to lead to enlarged glands, and to a cartilaginous tumour of the size of an egg adjoining the inferior cava. An outgrowth of cartilage protruded from this tumour into the vein, and cartilage, carried perhaps by the venous blood, was found in the pulmonary arteries (*Medico-Chirurgical Transactions*, vol. xxxviii. p. 247). See also vol. i. p. 533 of the present work, for observations by Virchow and De Morgan on the same subject.‡

Fibrous, fibro-cellular, and fibro-nucleated tumours, do not affect the glands; but when, though not adopting the structure of malignant disease, they assume its clinical character, they may in their dissemination involve the glands. Of myeloid tumours of bone, it is probably too much to assert that glandular disease is never a part of their natural progress, since, like medullary cancers, they are often amputated before the period at which the lymphatics would be involved. I have, however, seen the glands still healthy in a case of recurrent myeloid, after amputation of the thigh by Mr. Le Gros Clark. Chronic abscesses in the substance of organs, such as are

* *Pathological Transactions*, 1868, p. 394.

† Bennett, *On Canceroid*, p. 110.

‡ 'M. Velpeau a présenté à l'Académie de Médecine (séance du 28 juillet 1824) un encéphaloïde du testicule, avec des traînées cancéreuses le long du cordon spermatique, et un caillot d'apparence fibrineuse dans la veine cave, à quatre travers de doigt environ au-dessus de la naissance des deux veines iliaques. Le caillot était formée de matière encéphaloïde non ramollie.'—Kuhn, *Gazette médicale*, 29 juin 1861.

sometimes confounded with more important tumours, do not occasion an enlargement of the glands. An hydatid cyst may be covered with extremely large lymphatic vessels, yet occasion no disease of the subordinate glands. In an instance of a tumour in or near the female breast, which contained echinococci, and which had been suspected to be of malignant nature, the glands were entirely free from disease. A considerable enlargement of the inguinal glands took place in the course of a case of extremely rough osteo-arthritis of the hip-joint, and was attended with œdema of the limb. The intercurrent glandular affection subsided during prolonged rest. In such a case (Mr. Hatherley's), the shoulder-joint was affected, and enlarged glands in the neck for a considerable time simulated a sub-clavian aneurism.

Pyæmia is not necessarily attended with inflammation of lymphatics, but there are a few general diseases in which those parts do share. These only of them, in addition to those which form the subjects of the present essay, may be mentioned: variola, vaccinia, typhus, plague, hydrophobia, glanders, and farcy. I would add a few remarks upon ulcers and erysipelas.

Ulcers.—The glands above old ulcers are often found enlarged, and, on some occasions, tender; but they rarely need attention, and little, if anything, is known of the results to the glands from chronic ulcers of the bowel or uterus. When an ulcer, however, is situated near or connected with any form of tumour, enlargement of the glands, though only such as may attend any ulceration, may give to the case the semblance of cancer. No conclusion as to the cancerous nature of such an ulcer should be formed upon the ground of co-existent disease of the glands, without considering the amount of irritation of skin, and the character of the ulceration. By rest, a proper posture of the ulcerated part, and appropriate soothing or other treatment, such enlarged glands will often subside. I have known this to occur when the ulcer existed over a vast cysto-sarcoma of the female breast, and even when the primal irritation was an inflamed state of common carcinoma of the mamma. On the other hand, cancer does sometimes come on in a chronic ulcer, and then produces a very great enlargement of the glands.

Erysipelas.—The exanthemata which extend over the whole integument of the body, as scarlatina and rubeola, do not perceptibly affect the lymphatics; but almost all limited inflammations of the skin are accompanied with some degree of tenderness

or painful enlargement of the glands of the part. After blisters, upon the irritation arising from many surgical applications to the skin, in urticaria, in the cutaneous inflammation following an ordinary bruise, it is often met with, but it is most frequent in erysipelas. When that disease arises on unbroken skin, adenitis is an early, although a slight, symptom, and little noticed in comparison with the primary cutaneous eruption. But when erysipelas originates at a wound, the glands are sometimes swollen and tender before any blush can be discovered on the skin. They are stated to have been found red in an enteritis, which was recognised as erysipelatous;* and the almost invariable occurrence of adenitis at the commencement of the disease goes far to support the opinion, that the first inflammation of erysipelas is in the lymphatic system. In all cases except those treated of in the section on *inflammation of the absorbents*, the glandular affection is transient, and requires no special treatment.

Morbid contents of lymphatics.—Since it is a part of the healthy function of the absorbent system to receive the matters discharged into its radicles by the tissues, it happens that in disease also morbid substances find their way into it. Pus is frequently seen in the absorbent vessels of the pelvis in cases of fatal uterine inflammation. It was found, too, by Dr. Bright in tortuous lymphatic vessels, as large as iliac arteries, on the walls of a vast hepatic hydatid cyst.† Virchow‡ found still remaining in an axillary gland some cinnabar, which had been inserted by tattooing in the skin of the arm fifty years before death. Similar but less remarkable facts have been long known. Lapidaries have the lymphatic glands near the bronchi filled with earthy concretions, which are supposed to consist of inhaled stone-dust. Poncy saw the thoracic duct and its glands full of a cheesy substance. Perhaps the most common morbid material met with in this system, excepting strumous and cancerous matter, is some form of chalky concretion. Large masses of it may be found even in young subjects, whose glands have probably been early affected with scrofula. Assalini found it in the thoracic duct. Scherb saw a calculus in the same canal, and took it to be the cause of a dropsy. Cheston

* *Gazette médicale*, juin 7, 1856.

† Guy's Hospital Museum.

‡ *Cellular Pathology*, translated by Dr. F. Chance, p. 185.

observed a thoracic duct so filled with bony matter, which had been absorbed from a spina ventosa of the ilium, that air could not be blown through it.* Some glandular chalky concretions in a young pig are stated by Vulpian to have been found tinted by madder, with which the animal had been fed.† Finally, it is asserted that worms have been discovered in human bronchial glands, as well as in the glands and absorbent vessels elsewhere.‡

Obstructions and obliterations of the lymphatic vessels.—When Sir Astley Cooper tied the thoracic duct in the necks of some dogs, the receptaculum chyli burst, and a copious extravasation of lymph took place. A similar result was once observed in the human subject to follow a more slowly formed obstruction by disease,§ a fatal peritonitis ensuing upon the escape of lymph through the rent into the peritonæum. The museum of Guy's Hospital contains a specimen of a lacteal larger than a pullet's egg behind a diseased mesenteric gland. In the same museum is a thoracic duct completely compressed at its upper extremity by cancerous cervical glands. The duct is not at all dilated; but as there is another mass of cancer in its immediate vicinity near the pancreas, it is not improbable that the influx, as well as efflux, of lymph through it was hindered. Mascagni, attempting to inject some pulmonary absorbents, found the bronchial glands so obstructed that the mercury rather burst the vessels than traverse the glands. Sömmerring, without accounting for it, relates the instance of a robust woman suffering from ankylosis of the knee, in whom the absorbents of the thigh were varicose, and so tensely filled that, upon being pricked, their fluid contents spirted violently forth, and that the foot was affected with a kind of œdema.

A varicose condition of a lymphatic vessel may possibly arise from another cause than its obliteration, contraction, or compression. There may be a regurgitation at the upper orifice of the thoracic duct, or there may be an accidental communication between an absorbent and a blood-vessel, an arterio-lymphatic or a veno-lymphatic aneurism. Such a case might be that of

* *Phil. Trans.* vol. lxx. part ii. p. 323.

† Potain, *Lésions des Ganglions lymphatiques viscéraux*, p. 33.

‡ Davaine, *Traité des Entozoaires*.

§ Dr. Cayley's case of Obstructed Thoracic Duct; Rupture of the Receptaculum Chyli; Peritonitis. *Path. Trans.* vol. xvii. p. 163.

a thoracic duct, figured but unexplained by Cruikshank, in which the vessel is greatly enlarged and tortuous. Its diameter is nowhere less than four times its natural size, and, being increased in length as well as in calibre by the great power or weight of the stream within, it lies in many closely adjoining loops, which stretch to and fro across the vertebræ.

The *excision of glands* is rarely required, except in cases of cancer. A single gland in a state of chronic enlargement sometimes becomes troublesome, and may be taken away. Occasionally a tumour is removed from the axilla or neck, which has been of long duration, and recently painful or inconvenient, and which is found upon excision to be a cluster of strumous glands, or a single one enclosing a little pus. Gross once removed from the neck of a middle-aged strumous woman a small chalky tumour, which proved to be a degenerated gland. But it is long since surgeons have given up deliberately removing masses of strumous or merely enlarged glands with the knife. The large tuberos clusters of absorbent glands in the necks of scrofulous subjects seemed to invite that treatment; but when once undertaken it was found to be so formidable, gland after gland presenting itself for extirpation as the more superficial were removed, that the operation was often abandoned before it was completed. It rarely had any issue but that of early death by the development of phthisis in the lungs.

The extirpation of cancerous glands proceeds on the same grounds as those on account of which the primary tumour is removed. It is not necessary to repeat in this place the facts and arguments by which this rule of practice has been supported in the essay on CANCER. The necessity of taking out the whole gland and the tissues surrounding it is absolute. It is not enough to open the fascial sheath, in which such glands sometimes become embedded, and merely enucleate them. A clear halo of healthy structures should be removed with them. The difficulty of effecting this probably goes far to explain the fact that little success attends the extirpation of the femoral and higher cervical glands, as compared with those in the axilla; and the cases are comparatively very few in which it is proper to attempt it in the groin and neck.

DISEASES OF THE VEINS.

JOHN HUNTER was the first to describe inflammation of the lining membrane of veins.* Aretæus † had long before referred to some such disorder; but the disease he told of was so ill defined, that no one profited by or sought to advance his crude idea. Century after century surgeons continued to puncture, divide, and excise veins, fearless of the result and innocent of their inflammation. Troublesome symptoms, it is true, sometimes followed these operations; but they were referred to nerves, tendons, or fasciæ—anything rather than the veins—to nerves more especially.

‘I was called in haste,’ says Ambroise Paré, ‘to see his Majesty.† He had been let blood by a surgeon, and a nerve had been wounded in performing the operation, at which the king cried out with pain. The arm became contracted, and the pain diffused throughout the entire limb. I applied a plaster over the wound to assure its closing, and bathed the part with warm turpentine and spirits of wine to allay the irritation, the arm being bandaged to the shoulder, and after a time the symptoms began to abate.’

Gangrene, he further states, may attack an arm after vene-

* Phlebitis, so named by Breschet, from the word φλέψ (φλεβός), which was employed by Hippocrates to designate the channels which conveyed fluids, the term artery having reference to the air-passage alone. Thus, under the name of veins were included the various secretory canals, as the bile-ducts and the ureters; and hence Celsus wrote ‘a renibus singulæ venæ, colore albo, ad vesicam feruntur: οὐρητῆρας Græci vocant’ (*De Re Medicâ*, lib. iv.). Praxagoras first distinguished veins from arteries; for Aristotle, though he gave the name of aorta to the vessel which still bears that title, continued to write of it as one of the veins. See Galen *de Hip. et Platonis Dogmatibus*, lib. vi. c. 10; Galen *de dignoscendis Pulsibus*, lib. iv. c. 2; *Le Système veineux*, par le Docteur Verneuil, Paris, 1853.

† Κεφ. η' περὶ τῆς κατὰ τὴν κοιλίην φλέβα ὀξείης νόσου. Sydenham edition, London, 1856.

‡ Charles IX. of France.

section, and may prove mortal. 'I have known a lady to die,' writes Dionis, 'from diffused inflammation of the limb after a bleeding from the foot.'

Paré, treating of varices,* observes: 'sometimes in the limbs they contain a thrombus of blood, dry and hard, which, the vein being opened, should be evacuated.' Petit writes a description of the formation of clots in obstructed veins, and of some of the changes they subsequently undergo.† Discussion was held respecting other clots or polypi (*polypes veineux*), as they were termed, which were found in the heart; and between Haller, Morgagni, and A. and J. Pasta, opinions differed as to the manner and time of their formation.‡ Langswert wrote 'de inflammatione venarum' in the section of his work, *De Morbis Arteriarum et Venarum compositis*,§ but beyond the suggestive name made no advance upon the subject. Attention, however, had been thus drawn to the ill consequences which occasionally followed wounds of veins, and the formation of clots in their canals was recognised in connection with varices and with obstruction.

Meckel, Frank, and Sasse followed Hunter in describing inflammation of the inner coat of veins; and from their time this disease (divided into the adhesive and the suppurative) has been amply illustrated by numerous observers, and by none more clearly than by Gendrin, who thus describes its morbid anatomy.||

He finds the inner tunic of an inflamed vein at first of a more or less deep red colour; but the evidence derived from this condition is often valueless from the attendant blood-staining. On separating the inner coat from the middle, which can be done more easily than in the healthy state, the injected capillaries become evident, even in the structure connecting the inner with the middle coat. After a while the inner coat becomes uniformly red, and is less transparent, so that vessels beneath are no longer distinguished. It has lost its

* *Œuvres complètes d'Ambroise Paré*, par J. F. Malgaigne, tome ii. pp. 268 et seq.

† 'Sitôt que le tronc des vaisseaux est entièrement bouché par le premier caillot, le sang qui remonte par les branches se coagule à mesure qu'il arrive, la tumeur augmente et devient plus dure.' He then describes softening of the tumour thus indurated, which he ascribes to separation of serum from the clot: 'c'est cette sérosité qui fait la mollesse.' *Traité des Maladies chir.* tome ii. p. 42.

‡ J. Pasta, *De sanguineis Concretionibus*, Bergami, 1786.

§ Pragæ, 1763.

|| *Histoire anatomique des Inflammations*, tome ii. p. 16.

polish, and even has become somewhat rough. It acquires, if the disease progresses, a swollen and villous appearance, and, but for its easily tearing, can be readily detached from the middle coat. The latter quickly thickens, so that the vessel resembles an artery, but is less resisting. The external coat is also affected and infiltrated with serum or blood. The cellular sheath becomes involved, so that the whole forms a blended blood-stained mass. A membrane sometimes lines the vessel, of little consistence, forming a cheesy pulp when pressed between the fingers.

Ribes, however, has observed this membrane firm and resisting, and even organised, though but slightly adherent to the adjacent wall. Sometimes it adheres so firmly that it cannot be completely detached, and it occasionally covers a great extent of vein-wall, as in a case described by Chaussier,* in which the left renal and adjacent veins were thus coated. The blood now forms on the wall of the vessel fibrinous clots, more or less decolorised, by which the tube becomes blocked up. These clots are not formed at once, but 'fresh fibrinous layers are continually being added, and in a proportionately very short time a plug is formed which fills the entire calibre of the vein.'

'This fibrinous coagulum extends both above and below, far beyond the limits of the portion originally inflamed; the plug, however, ceasing by degrees to be made up of concentric layers, gradually passes into a tapering coagulum, more or less tinged with the colour of the blood, and little, if at all, adherent to the walls of the vessel. In all the branches of veins which immediately lead to the plugged portion, save those which have other channels by anastomosis, the blood stagnates and coagulates. The plug is shorter above, and seldom extends beyond the point of junction with the nearest venous trunk.'†

Such is an account of changes which are said to accompany adhesive inflammation of veins. In a word, their inner and middle coats become inflamed, lymph is exuded upon and clings to the surface next the blood, the latter coagulates, and so the vein is filled partly with lymph and partly with clots. Then, as in every other inflammation, the mingled products undergo further changes.

It is, however, difficult to receive these statements in the face of facts which throw doubt upon the existence of an adhesive phlebitis. First, be careful, suggests Ribes, to distinguish all this redness of the lining membrane of veins from post-mortem congestion. Veins, after death, quickly become stained by the fluids adjacent, more rapidly in some cases than in others. Their discoloration is uniform, and, especially in small vessels, extends to the surrounding tissue, and this more particularly in the dependent parts 'in inflammatory subjects from the

* *Revue méd. française et étrangère*, 1825, tome iii. p. 9.

† Hasse's *Path. Anatomy*, English trans. p. 14.

ready separation of decolorised fibrinous concretions, in others from dissection of the corpuscles.* Many have been misled by this discoloration, easy as its recognition may appear; for example, those who regarded phlebitis as the principal seat of erysipelas; and Ribes himself, when he wrote of an inflammation involving the roots of the portal vein of all persons dying with adynamic fever. Those also who assert that they have seen a phlebitis extending through many veins until it reached the heart, are equally deceived by this post-mortem staining.

The experience of Guthrie,† who doubts the existence of an adhesive, or, as he terms it, a healthy inflammation of veins, is opposed to Gendrin's description; and Travers,‡ whose statements, by the way, are contradicted by Bichat,§ concludes that 'the internal coat of a vein is, when compared with an artery, difficultly susceptible of adhesive inflammation. Indeed, the process of healing and division by ulceration seems to be conducted without any sign of inflammatory action; but the indisposition of the venous membrane to inflame is not, as appears to me, inconsistent with its tendency, under adequate excitement, to inordinate and excessive inflammation. It is not unusual to find the morbid action of parts that are difficultly roused least controllable when once set up.' Frank and Sasse saw matters very differently. They observed a deep redness of the internal coat diffused throughout the vessel, and after ligature 'a sort of false membrane, resulting from the morbid action.'||

Cruveilhier¶ observed that vascularity was not seen in the lining membrane of veins, even when the blood charged with irritants from inflamed parts caused an inflammation; for 'I do not regard the phlebitis as the first change, but consider the coagulation as anterior to the phlebitis.' Hunter** thought it difficult to conceive 'how adhesions should take place on the internal surface of veins; since it is most obvious that the

* Gendrin, op. cit. tome ii. p. 5; Ribes, *Revue méd. française et étrangère*, tome iii. p. 5. 1825.

† *A Treatise on Gun-Shot Wounds*, 3rd edit. p. 299.

‡ *Surgical Essays*, part i. p. 255.

§ *Anatomie pathologique*, dernier cours, chap. xiv. p. 266.

|| *Sylloge Opusculorum selectorum; dissertatio Hallæ habita anno 1797*. p. 185. Also Frank, *Epitome de Curand. Hominum Morb.* lib. i. p. 187.

¶ *Traité d'Anatomie pathologique générale*, tome i. p. 290.

** Hunter, *Works*, vol. iii. p. 584.

coagulable lymph thrown out by the exhalants on the internal surface of the vein, mixing with the same fluid circulating with the other parts of the blood, would be swept away without producing any effect. But since such adhesions do in fact happen, the coagulable lymph must undergo some change connected with the disposition which produces its extravasation.'

Travers was the first to show that veins, after ligature or division, repair without an adhesive inflammation. Three preparations illustrate this fact. One, in the museum of St. Thomas's Hospital,* is thus described: 'Appearance of a vein divided by the ligature, which came away on the twenty-fifth day. The upper part of the vein is filled with firm layers of coagula, which so tenaciously adhered to the inner membrane as to be separated with difficulty; when separated, the surface was found to be perfectly smooth and natural.† The second preparation shows the result of a ligature applied to the jugular vein of a horse for twenty-four hours. The inner vein-wall, thrown into longitudinal folds, is otherwise natural in appearance, whilst a good deal of lymph is accumulated externally around the ligature. The third, which, with the preceding, is in the museum of St. George's Hospital,‡ shows the effects of a ligature, including part of the parietes of the jugular vein of a horse. Some fibrine is deposited in the track of the thread and in a small pouch below, but no evidence exists of any inflammation of the lining membrane, and this three days after application of the ligature.

In the museum of St. Thomas's Hospital § is a preparation of the jugular vein of a horse, with a circular aperture formed by ulceration of the wound made in phlebotomy. Its internal margin and the surrounding membrane is coated with adhesive matter. As in this case the interior of the vessel communicates with the tissues outside the vein, the adhesive material may have made its way into the vessel from diseased tissues which surround it. But, respecting this presence of adhesive material within veins, an error was originated and perpetuated by the experiments of Gendrin. 'Should any imagine,' writes Hasse, 'this false membrane to be not the product of plastic effusion from the coats of the vein, but an immediate deposit from the

* Series v, 151.

† Series vi. 173, 193.

‡ Travers, *Surgical Essays*, plate viii.

§ Series v, 152.

blood, let him refer to the experiment of Gendrin. Having secured a portion of an artery between two ligatures, and entirely cleansed it of blood, that experimentalist discovered, after throwing in an irritant injection, a plastic membrane deposited within the part so insulated, filling up the whole calibre of the vessel; and he affirms that similar results followed in experiments upon veins.' Notwithstanding the credit this view long obtained, and the support it received from authorities in this country, its accuracy was disproved by Lee. Having found that inflammation of the coats of the veins only occurred when the blood had previously coagulated in them, he was induced to believe that the deposit found in the veins might be derived directly from the blood. Gendrin's experiment was, therefore, repeated; and when precautions were taken to exclude all blood from the vessel, no lymph was effused in the vein.

In repeating this experiment, I find, however, that lymph is occasionally found within the veins, but that its presence is due to an effusion external to the vessel. The precaution of closing, by ligature or otherwise, the opening through which the irritants are introduced, effectually secures its absence. The following experiments show the result as this precaution is, or is not, taken. They show that the lymph, when present, finds its way into the vein from without, and is not exuded from or through the lining membrane. Neither, in animals, does the internal coat inflame when irritated.

1. Part of the femoral vein of a dog being selected, free from anastomosing branches, a ligature was applied so as to stop the blood coming from the extremity. The vein was then opened by a longitudinal incision, and the blood in the vessel was removed. A second ligature was then applied between the longitudinal cut and the first ligature, and a third was tied between the wound and the heart. After twenty-four hours, lymph was found in the latter interspace, but not in the first. There was also an abundant deposit of lymph external to the vessel.

2. Part of the femoral vein of a dog having been included between two ligatures, was punctured, all blood removed from its interior, and two small pieces of lead introduced within the portion of the vessel isolated by the ligatures. Twenty-four hours after the operation the vein was surrounded by lymph, a considerable quantity of which had entered the vessel through the puncture distending its canal, as may be seen in the preparation.

3. The femoral vein of a dog having been exposed, an experiment was made which resembled the preceding; but the ligature nearer the heart was shifted after introduction of the foreign bodies, so as to cut off the portion of vein in which the pieces of lead were included from communication with the puncture in the wall of the vessel. The lining membrane of the portion of vein

thus isolated presented a natural appearance twenty-four hours after the operation.

4. A small piece of lead was introduced within the femoral vein of a dog and there suspended by a thread, as seen in the preparation. The puncture in the vein-wall was then closed by a ligature, which had the effect of slightly narrowing the canal of the vessel. The blood was then allowed to flow through the vein for forty hours. At the end of this time the lining membrane of the vessel retained its natural appearance.*

From these considerations it is manifest that adhesive phlebitis has been very variously described and accounted for, and that its occurrence has been denied by some pathologists. There can be no doubt but that veins are repaired without its aid, and experiments upon animals, taken for what they are worth, show that the lining membrane of these vessels does not inflame when irritated. Absence of vessels from this membrane points, one would think, a reason for its immunity. A tissue thus circumstanced may eventually be involved when adjacent parts are affected, but it rarely originates disease. As the barrier between tissues often inflamed on the one hand, and the blood-stream on the other, it would obviously discharge an important function did it prevent lymph from being effused on the internal surface of the vein. For although this lymph might be swept away without producing any local effect, it could not be mingled with the blood without risk of spoiling that fluid, or of causing secondary mischief by becoming entangled in, and so obstructing, the capillary vessels.

I prefer, therefore, to consider what has been termed adhesive phlebitis under the name of thromballosis.

THROMBALLOSIS.

The changes which result from *coagulation of blood* within the veins (thrombus, as Petit terms it †) may easily be mistaken for processes of an inflammatory character, unless the beginnings of the disease are accurately observed.

Causes.—As it has been elsewhere shown ‡ that the blood-fibrine, under certain conditions, is apt to coagulate spontaneously within the vessels, it will here suffice to recall the fact. Coagula may indeed form, as a means of repair, be the blood

* Museum, St. Bartholomew's, series xiii. 156.

† Also named *embolism*, from ἔμβολον, a plug. The term *thromballosis* more correctly indicates this disease (θρόμβος, a clot, and ἀλλοίωσις, to change).

‡ Vol. i. p. 275.

condition what it may. They do so in arteries after application of a ligature. They do so in veins when wounded or when torn across, and are then sufficient to close the rent, and eventually to repair it. In these cases the coagula are limited in their extent. But in other cases, and to these our attention is now directed, when a clot is formed within a vein, it increases and extends from one to another, until having commenced perchance in a vessel of small size, it reaches and fills the largest.

This remarkable tendency of the fibrine to coagulate within the veins may exist, unsuspected, in the ill-nourished and feeble, or may be slowly induced during the progress of disease. Some trifling circumstance is then sufficient to call it into action: Bouillaud states * that those dying from phthisis or from cancer often suffer from the formation of clots in veins.

In one case the external iliac was thus filled with a coagulum where compressed by intestine distended with feces. In another, a tumour pressed the vena cava; in a third, a cancer growth the internal iliac; and where the pressure fell, there each vessel was closed by coagulum.† In the body of a young man who had long lain in one of the wards of St. Bartholomew's Hospital with his thighs drawn up on the abdomen, the femoral veins were closed by clots above the junction of the profunda, and as high as Poupart's ligament. The mere flexing of the vessels had sufficed to determine the coagulation, as he slowly died with phthisis of the lungs.

The circumstance which called the coagulating predisposition into activity, seems, in these cases, to have been (1) the pressure upon the vessel. So again in the following case.

On December 6, 1860, I examined the body of a male patient who had long suffered from dilatation of the pelvis of the right kidney, in consequence of impacted calculus. Pericarditis was the immediate cause of death. The vena cava inferior was compressed by the dilated pelvis (which formed a cyst holding four pints of fluid), and was somewhat narrowed above the junction of the common iliac veins. The right common iliac was filled by a coagulum in part soft and blood-stained, decolorised where in contact with fluid blood coming through the opposite vein. It extended far towards the leg, even to the veins about the middle of the thigh, and the right lower extremity was cedematous.

In these cases, the pressure is often slight, and generally acts upon one side of the vessel, the vein being free to yield in the opposite direction. They must be distinguished from those

* *Traité clinique des Maladies du Cœur*. Bidault (*Recherches sur les Concrétions sanguines des Veines*, Paris, 1850) states that Legroux first drew attention to the spontaneous formation of clots in veins.

† See cases by Forbes and Holberton in *Med.-Chir. Trans.* vol. xiii. p. 203, vol. xvi. p. 62; also Museum, Guy's, 1523⁵⁰.

cases in which the pressure is made upon the whole circumference of a vein, or if acting on one side, compresses the vessel against a resisting substance such as bone. The vein is then filled with a coagulum distinct or mingled with an ingrowth from any tumour which may happen to surround it, and eventually, if the vessel become obliterated, clots form on the distal side of the obliteration, just as after application of a ligature.

This occurred, for example, in the case of a woman, aged twenty-three years, who suffered from osteoid cancer, involving the lower part of the left femur and the popliteal space. The limb was amputated at St. Bartholomew's Hospital. The diseased portion was examined November 23, 1861. The popliteal veins, there were two, were obliterated, and could not be traced amidst the substance of the tumour; but above and below the obliterated portions the vessels were filled with firm colourless coagula.

Other circumstances, however, more often determine the formation of coagula. (2.) Inflammatory changes in the tissues which surround veins. Thus at the base of an extending ulcer the veins are filled with coagula.* As the disease advances, the clotting goes before, and plugs portion after portion of adjacent veins. Rendered solid, they may indeed soften and slough as the disease progresses, but hæmorrhage is, as a rule, prevented by their previous obliteration. (3.) Laceration of a vein, as when the placenta is expelled from the uterus. Some blood escapes and coagulates without, and some, but not much, within the vessel, which is itself contracted. Thus, and by subsequent changes, the vein is permanently closed. The extension of clots, which results in either of these circumstances, though of common occurrence, has received scanty attention.

In illustration, I will narrate two or three cases.

In the body of a man brought to St. Bartholomew's for dissection, death having resulted from phthisis, the nates were covered with sloughing sores. The left femoral, just below Poupart's ligament, was filled with a firm coagulum which ascended to the junction of the epigastric vein. Attention was drawn to numerous veins about the base of the sloughs, which were more than usually conspicuous from being distended with clots. They converged towards and formed the left internal circumflex, and so extended direct to the femoral; and, without doubt, accounted for the clot which had formed there in direct continuity with those in the smaller vessels.

In February 1864 a woman, aged twenty, died, after amputation of the thigh, with symptoms of pyæmia; there was no evidence of vein obstruction about the

* Museum, St. Bartholomew's, series xiii. 61; Middlesex, vi. 52; St George's, series vi., Nos. 176, 177, 178.

vessels of the thigh, but on making a careful examination of the pelvis, to which I was led by the fact that a large bed sore had formed over the sacrum, a thin plate of fibrine was found at the junction of veins to form the right common iliac. This fibrine partly hindered the flow of blood from the external iliac, but being broken away from the mouth of the internal iliac, had allowed a quantity of soft clot *débris* to pass into the circulation, this came from the ischiatic vein, which was filled throughout its entire length by old and softened coagula. The lungs were filled with secondary deposits. In this instance the thromballosis had extended in the veins about the sore on the sacrum, not from that about the amputation wound of the thigh.

My friend, the late Dr. Baly, sent me the following report of the case of a female aged sixteen years, a prisoner in Millbank. On January 20, 1844, she was placed on the sick list. She was of a strumous aspect, and had suffered from attacks of diarrhoea and of dysentery, attended with pain about the head and cramps. The day following, the cramps ceased. Pain and tenderness about the epigastric region persisted. The third day she began to complain of pain in the right side of the head, and the right side of the face was slightly swollen. The gums were somewhat affected by mercury she had taken. A glazed red streak extended from a pustule on the right side of the nose to the inner angle of the eye, terminating abruptly. A good deal of the pus had discharged from the pustule during this and the preceding day. The fourth morning she was seized with convulsions of an epileptic character. She became insensible, and on the fifth day she died. The body was examined twelve hours after death. The right cavernous sinus was filled with clots and puriform material, as also was the ophthalmic vein. Elsewhere, each sinus contained dark fluid blood. Two veins, one from the dura mater, the other from the brain, were filled with clots. The vein by the side of the nose also contained coagula. Part of the brain lying over the cavernous sinus was ecchymosed, the blood was coagulated in its vessels, and its tissue softened. From the pustule to the softened brain tissue the progress of the disease was distinct, and not to be mistaken.

Examples to show how veins, after wounds and rupture of their walls, become obstructed with clots, may be taken from those cases of œdema of the legs, so often following parturition, bad fractures, and even severe contusions.

On July 19, 1855, a woman, aged twenty-four years, was admitted into St. Bartholomew's Hospital, who had enjoyed good health until, about six months before, she had fallen from a height, and severely bruised herself about the pelvis. Two months after, she was confined at the full time. A few weeks before, she had noticed some swelling of her legs, and she subsequently suffered from obscure abdominal pains, with occasional hæmorrhage from the vagina. Her emaciation became extreme. The lower extremities became permanently œdematous, and hard cords could be traced along the course of the principal veins. Exhausting diarrhoea baffled treatment, and, sinking gradually, she died about eight months after her confinement. The femoral and all the iliac veins being removed after death, presented the following appearances. In places they were greatly distended, firm, and resisting. Between such portions they were contracted and empty. All smaller veins opening into these trunks were occupied by firm, decolorised clots. The tissues around were natural, save about the femoral veins, where they were somewhat thickened. The coagula

clung pretty firmly to the walls of the vessels; they showed an arrangement of concentric layers, easily separated one from another. At the contracted points, the walls, as elsewhere, presented a natural appearance. All other parts of the body, excepting the œdematous legs, presented a natural appearance.

Again: a woman, aged sixty-two years, died in the same hospital, forty days after a comminuted fracture from direct violence about the upper and middle part of her right femur. Her death resulted from exhaustion; she sank gradually, with extensive bed sores. The right lower extremity was slightly œdematous. Great ecchymoses were found about the adductors and the vastus internus. The profunda and its formative branches were plugged as high as the junction with the femoral vein with softening blood-stained clots, of the existence of which there was no suspicion during life. The fractured femur remained ununited. The important relation between these clots and the occurrence of non-union will be subsequently noticed. The predisposition which inclines the blood to form these continuous clots is thus called into activity by accidents of common occurrence.

The coagula extend in all cases in one of two directions—(a) against, (b) with, the blood-stream. To assist in explaining their extension, the formation of a coagulum in an artery on which a ligature has been tied, must be referred to. It is thus noticed by Jones:

From these circumstances it appears that the enlargement of the portion of the artery between the first collateral branch and its extremity is prevented; but it is obvious that there must be a small quantity of blood just within the extremity of the artery, and which is more or less *completely at rest*; it *therefore coagulates*, but does not appear in every instance to form a coagulum capable of filling up the canal of the artery; for, as may be observed in many of the experiments, several hours after the artery had been tied, there was only a slender coagulum formed in its extremity. I am therefore disposed to think that though the artery cannot accommodate itself to the blood determined to it, yet it undergoes such a degree of contraction, as occasions too much motion in the blood which it contains to admit at once of its complete coagulation. It is a fact, that in most cases only a slender coagulum is formed at first, which gradually becomes larger by successive coagulations of the blood; and for the same reason it is that the coagulum is always at first of a tapering form, with its base at the extremity of the artery.*

The researches of Stelling† add little, if any, information. He observes, that the arrested blood forms a conical mass, whose apex is near the first lateral branch, and whose base is seated on the extremity of the vessel, and is contained within a funnel of blood in partial motion.

Now respecting this coagulum (thrombus) two facts deserve

* *On Hæmorrhage*, p. 159. See also Haller Op. Min. t. i. exp. 54. 'Sensim vero de arteriâ ligatâ sanguis collectus ita refugit ut nullus supra vinculum sanguis maneret, sub lino vero copiosior et stagnans superesset.'

† *Die Bildung und Metamorphose des Blutpfropfes oder Thrombus in verletzten Blutgefässen* Eisenach, 1834.

to be noted. The first is its formation independent of the division of the middle and internal arterial coats. If a broad ligature is tied round an artery so as to close its canal without lacerating the coats, a clot is readily formed between the ligature and the first branch on the cardiac side.* The second fact is that the blood is not stagnant above the ligature, that is to say, in a state of rest, as is usually assumed. On the contrary, it is agitated in an orderly manner, so that the fibrine is as it were churned out of the blood to form the coagulum. This may be illustrated by the following experiment. Let an opening (*a*) be made in the side of a common glass test-tube. Between this opening and the closed extremity of the glass let the latter be filled with sand. A stream of water directed

FIG 151.



through an elastic tube adapted to the orifice (*b*) of the glass will quickly remove the greater part of the sand through the lateral outlet (*a*). What remains will assume a spiral shape, whilst the particles of sand as they are whisked away will indicate a spiral movement of the water-stream, as shown by the plain and dotted lines in the annexed diagram. As the relations are varied between the velocity of the stream, the diameter of the outlet, the diameter of the tube, and the distance between the closed extremity and the lateral opening, so of course will the result be modified.

It is in the midst of such an orderly movement, that fibrine is probably separated from the blood above a ligature and forms the spiral and conical clot, which extends to the first lateral branch (where the churning movement ceases), and which, consisting of separated fibrine, is from the first colourless.†

Under like circumstances, clots form and extend in an obstructed vein (Fig. 152, *a*) in opposition to the stream as far as the first branch, as at *b*, where the blood turns back through the collateral vessel (*c*); they also form where the blood regurgitates, as in the subclavian vein from disease of the heart;‡ but

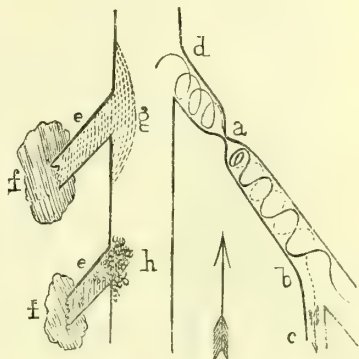
* Museum, St. Bartholomew's, series xiii. 141.

† Reference is made to these observations in the article *Venenwunden* by O. Weber in the *Handbuch der allgemeinen und speciellen Chirurgie*, p. 99 et seq.

‡ Guy's Hospital Museum, 1521³⁰.

these coagula are produced less rapidly than in arteries, and their fibrine is often largely mingled with other blood constituents. The blood also finds its way into the vein on the cardiac side of an obstruction (*d*), and supposing vessels (*e e*) to be torn across, what with an external clot (*f f*) and the coagulation within, as at *d*, they are soon plugged to their junction with a larger vessel. The end of the clot in contact with the blood-stream, if in a small vein which opens into one of large size, is round or flattened; if, on the other hand, it

FIG. 152.



occupies the large vessel, its extremity, moulded by the lateral current, is tapering, or otherwise modified in its shape.* Beyond any such point the extension of the clot depends, as shown by Virchow, upon deposits from the blood as the latter flows over the coagula, and these additions of fibrine may be arranged in orderly layers (*g*), or may be deposited irregularly, leaving a rough surface, as at *h*.† By these accumulations the largest veins may be so nearly occluded that a slight additional coagulation at any moment completes their closure. Vessels thus plugged present the appearance shown in Fig. 153 (from an obstructed profunda vein), the yellowish or white clot, having as is usual a spiral shape, and coloured coagula filling its interspaces (often speckled with fragments derived from

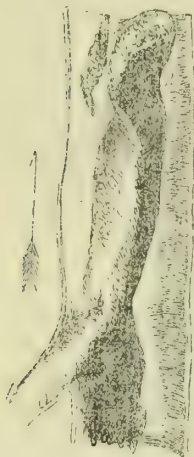
* See woodcut, vol. i. p. 276; also Museum, Guy's, 1521²²; Middlesex, vi. 52.

† It is from these projecting coagula that fragments and even large masses are separated, pass into the blood-stream, and are carried by it to be eventually lodged in distant organs. Several cases are recorded in which sudden death has been caused by the lodgment of such a fibrine mass in the pulmonary arteries; the consequences of their arrest in the arteries of the brain, whither they are usually carried from deposits on diseased valves of the heart, have been fully investigated by Kirkes; and the whole subject of occlusion of the arteries from this cause will be found treated of in the following essay. Plate viii. attached to Davis's paper in *Med.-Chir. Trans.* vol. xii., and preparation 1521²² in Guy's Hospital Museum, are excellent illustrations of coagula in a position to be thus washed off by the blood-stream. See also recent observations by Bastian and others, and by Tuckwell in *St. Bartholomew's Hospital Reports*, vol. v.

the fibrine masses), the whole bearing below an impression of the vein-valves.

The changes hitherto described, although as often independent, are frequently associated with ordinary inflammation of parts around the veins, as may be seen in the greater number of the preparations in the London museums.

FIG. 153



As a consequence of such inflammation (the so-called adhesive phlebitis), small vessels quickly fill with clots; and if a main trunk is then examined, its inner surface will be found dotted over with what at first sight look like plates of lymph, but which are in reality the clots projecting from the branch veins, some firmly attached, some hanging loosely in the canal. From these, as starting points, the main vein becomes in turn obstructed with coagula, more especially if its outer walls are implicated in the inflammation, the clots having often a regular laminated arrangement. At the first large vessel which joins the affected vein the clotting is arrested by the incoming blood-stream; but,

if, as has been already shown, the disposition to clot-formation is strong, it is only checked at the junction of collateral vessels, and may extend with scarcely any limit either towards or away from the centre of the circulation.

When these clots are removed, the lining membrane of the vein beneath presents a natural appearance; but its outer and middle coats are not unfrequently thickened, and if there be much contraction of the tissues around subsequent to their inflammation, the vein may be thrown into longitudinal folds, or may become tortuous.*

As each coagulum is formed, it contracts; and it often happens, being firmly fixed by its roots, as we may term its prolongations into the small branches, that the vein-wall is drawn with it in its retraction, becoming condensed and thickened in appearance, so much so that when cut across it resembles an artery. Indeed this condition is generally mistaken for an inflammatory thickening of the vessel; but in the case of the young woman narrated at page 361, suspecting the

* Museum, College of Surgeons, 1725.

nature of the change, I removed the internal saphena, which was contracted, thick, and hard like a piece of whipcord, and having injected water into a part of the vessel, easily restored that portion of the canal to its ordinary size, and the vein-wall to its usual appearance, so that in the preparation* it forms a marked contrast to that part of the vessel which remains condensed. Had its walls been thickened by any inflammatory deposit, they would not have yielded to the slight pressure which was employed. I have recently had many opportunities of repeating this experiment.

Sometimes the coagulum shrinks to one side, being more tightly held by the branches in that than in the opposite direction, and under favourable circumstances the blood, incessantly endeavouring to insinuate itself into the obliterated vessels, may form a channel by the side of the clot between it and the vein-wall, or in rare instances (referred to by Ribes and others) may drill for itself a passage through the centre of the clot. Under such circumstances the circulation is re-established, though still hindered by portions of fibrine, which form bands and cords stretching across the canal.†

It more commonly happens that the obliteration is permanent and the vessel is lost to the circulation, the clot (frequently organised) and the vein ultimately forming a firm, shrunken, sometimes calcareous cord. The collateral circulation carries off the blood which should have passed through the lost vessel; though, before this is established, and even after, there is œdema of those parts from whence the return of blood is hindered, and occasionally even hæmorrhage. The extent and severity of this œdema (*white swelling*) will depend, (a) upon the size of the vein obliterated, (b) upon the extent of the obliteration, and (c) upon the sufficiency of the anastomosing vessels to remedy the obstruction. When the œdema is attended with considerable pain, a low state of inflammation is superadded. The part is swollen and hard, but does not pit on pressure, as in anasarca, and is not red, as in phlegmonous erysipelas. But these affections are nearly allied, as the one causes

* Museum, St. Bartholomew's, xiii. 157.

† Museum, St. Thomas's, v, 162, 168. With reference to the occasional dilatation of these clots and their connection with the formation of aneurism, see a case I have reported in the *Path. Trans.* vol. ix. p. 93; and *Remarks by Dr. Oyle on the Formation of Aneurism in connection with Thrombosis*, London, 1866.

cellular inflammation, and erysipelas itself almost always occasions an affection of the veins.

This œdema often embarrasses the repair of fractures, more especially when the breakage is near a medullary foramen and involves the laceration of a large vein, or when the tissues around are greatly bruised from the direct violence of the injury, so that clots form in the principal vessels. As this complication is of such common occurrence and of such serious importance, it is strange that attention has been so little directed to it in cases of tardy or non-union. It may be suspected when, about the fourth week after the injury, the parts continue or become œdematous, cold, and often aching. The remedy consists in endeavouring to improve the circulation through the superficial veins, which are least often obstructed, by friction with the hand and by position. It is, however, always a serious affection, as shown by the frequency with which opportunities offer for inspecting the bodies of old and feeble people who die some weeks after a fracture with no trace of union, but with numerous ecchymoses and plugged veins around the seat of injury.*

It depends upon the quality of the fibrine whether it causes these simple obstructions, or whether it softens and disintegrates, forming a thick yellow fluid, sometimes blood-stained, which resembles pus (puriform) in its appearance, and which, with the complications it may give rise to (pyæmia), has been already described.† The clot when softened is usually shut off (sequestered) in an upward and downward direction by newly-added coagula. And here I may observe, that the softening begins, as a rule, in the coagula last formed, not, as Virchow states, in those first deposited. For in the advance of the malady the patient's health fails, and the fibrine becomes more and more prone to disintegrate and soften into a puriform fluid.

The symptoms of obstruction of the deep veins are obscure, even when attended with ordinary inflammation of the parts around. There may be some constitutional disturbance; the superficial veins may be congested, and after a time the occurrence of œdema may be noted. When the limbs are affected, they feel hot and dry, are usually flexed, and cannot be extended

* See 'Notes on Non-uniting Fractures,' *Med.-Chir. Trans.* vol. li.

† See PYÆMIA, vol. i.

without considerable pain. If the superficial veins are involved, they can be felt as hard cords under the finger, the induration being due to the thickening of the tissues around, to the clots within, or, more often, to the two conjointly. The course of the attendant inflammation is marked by redness and tenderness, and may be distinguished from inflammation about the lymphatics by the small size of the cords in the latter, its superficial character, and the rose-coloured redness of the skin. The diagnosis between affections of the deep veins and of the absorbents is not so clear. An accompanying injury, from which the mischief may have started, and which is generally a contusion or an open wound of some kind, will usually suggest to us the probable condition of the neighbouring veins.

In many cases no danger is to be feared; but when large and important veins are extensively affected, as those of the pelvis and lower extremities conjointly, nutrition is so largely hindered that death by no means unfrequently results. The obstructions often cause serious complications, as has been already mentioned, and there is danger of portions being separated from the clots in the veins and causing secondary mischief in the capillaries of various organs (pyæmia).

Treatment.—If the nature of this affection is rightly understood, the description of its treatment becomes simple enough. The patient's health must be upheld by doses of bark, or of any other approved tonic; and a generous diet must minister to his amendment. If there be any error, it will be on the side of not doing enough in this respect. Locally, rest must be insisted upon, if possible in such a position as shall favour the circulation through the part affected. The circulation should be promoted in the superficial veins, as has been already indicated, as the surest means of relieving œdema. If there be pain from an inflammation, it may be soothed by warm fomentations; if it be chronic and from œdema, it is useful to give opium in some form, and thus for the time relieve it. Each case in which the symptoms are at all serious will probably require patient watching; for the disease, with its series of stages, the coagulation, the eventual obliteration and the righting of the circulation, is of slow progress, and must, after all, be left pretty much to nature. Our anxiety to render assistance should never lead us to the employment of such remedies as blisters applied to the œdematous limb; nor can aught but harm be anticipated from depletion, the use of mercury, or of such-like

powerful medicine. Except in the case of the complications to which I have referred, a favourable issue may be anticipated.

SUPPURATIVE PHLEBITIS.

It remains to refer to the so-called *suppurative* (diffuse) *phlebitis*. This disease is, in fact, nothing more than a diffused phlegmonous inflammation, and ought to be reclassified with disorders of that character, from which it was separated on account of a prevalent opinion that the inner membrane of veins was the part first and chiefly affected. This inflammation follows the course of veins which, acting as conductors, favour its rapid extension in the direction of least resistance; and hence, as a rule, the disease passes from the small to the larger vessels, since the cellular surroundings of the latter offer the easier route for its advance. That the parts around are first affected, and not the lining of the veins, is shown by the examination of fatal cases. There is no preparation of so-called suppurative phlebitis I am acquainted with in which the parts around the veins are not inflamed and thickened.

No patients in a fair condition of health could suffer from this disease. The worst they could be troubled with would be a limited (adhesive) inflammation of the parts around the vessels, with attendant obstruction of the veins with clots. But if the system is depressed and enfeebled, as when suffering from extensive ulcers, from large lacerations, or after severe operations, this disease, attacking wounds and adjacent structures, extends along the course of the vessels, just as in other cases it happens to extend along the subcutaneous cellular tissue, and is known as phlegmonous erysipelas. It arises from various local irritations; in one case, the puncture (venesection), in another, the division of a vein, is its starting point; and it often occurs after amputations, as after other wounds; not, however, in consequence of ligatures applied to veins. Whether these vessels be tied or not, this inflammation may supervene; indeed in every amputation, as remarked by Blandin,* the veins which accompany small arteries are always tied; and we have no right to argue that the ligature of a large vein is more likely to be followed by diffused inflamma-

* *Journal hebdomadaire*, tome ii. p. 579. Paris, 1829.

tion of its wall, than is that of the smaller vessels. Such an assumption cannot be justified.

Whilst remembering that various degrees of severity exist between the limited (adhesive) inflammation of the tissues around a vein, and the most severe form of diffuse suppuration of the same structures, we will take a bad case of the latter as giving a correct idea of the nature and progress of the disease.

On March 27, 1861, I examined the body of a man who died in St. Bartholomew's Hospital under the following circumstances. He fell from a height, and so upon some iron spikes, which penetrated one into either thigh. Diffused inflammation became established along the track of the wounds, more especially on the right side. On the fourth day, without material aggravation of the symptoms, the right saphenous vein became indurated along its entire length. The lungs became congested, symptoms of dyspnoea were added, and he died (typhoid) on the seventh day. The right wound extended across the thigh to its inner side, and unhealthy pus was diffused far and wide superficial to the fascia lata. The tissues around the saphena vein were laden with extravasated blood, and with unhealthy sanious pus. The glands, especially about the upper part of the thigh, were enlarged and blood-stained. The outer coat of the saphena was oedematous, the internal surface of the vessel was rough, and the inner coat was, for the most part, wanting. There was no increased vascularity of the vessel. Its canal was filled with sanious pus, and occasional shreds of blood-clots. Just above the inner ankle it was suddenly contracted, and contained a tapering coagulum; and here was the limit of the surrounding inflammation. The femoral vein, at its junction with the saphena, was laden with soft coloured clots, which extended into the external iliac. The lungs were congested and oedematous.

The changes in this and in allied cases may be described as an infiltration of the tissues around each vein with serum and corpuscular lymph. This quickly degenerates, and forms a series of abscesses, or rather a diffused collection of pus. The rapidity with which these results follow each other is most alarming. The veins at first contract, entangling as they do so, some few coagula; but presently such portions dilate. Beyond these, other parts of the same vessel are undergoing, as the surrounding disease advances, the earlier process of contraction; and again, beyond such portions, clots close their canal and mark the momentary limit of the disease. And so it extends, following the vein-course. All branch vessels are closed with clots, or involved otherwise in the disease, so that no blood flows through the vessel, and thus, and from the condition of the parts around, no nourishment can now reach the inner vein-coat; so it dies, becoming cloudy, forming an inorganic friable pulp, which gradually melts down until no trace of it

remains. The inner coat being destroyed, pus finds its way into the dilated vessels, either direct from the other vein-coats, or through them from the parts around; for these coats, deprived like the inner of their blood-supply, frequently perish in the course of the disease.

The symptoms which accompany these changes are of a low, even typhoid character, ushered in with rigors, and a general increase in the severity of pre-existing signs. If superficial veins are involved, the accompanying induration and congestion of the parts around will mark the progress of the disease; if the deep vessels are implicated, it is upon the accession of general symptoms, and upon the uneasiness about the parts affected, that we must rely for a diagnosis, which indeed is not always easily arrived at. When diffuse suppuration is established, a satisfactory issue is doubtful, although in the less severe cases we may succeed in limiting, and so in arresting the disorder.

To effect this, every effort must be directed to the support of the patient with stimulants, nourishing food, and tonics; warm fomentations applied to the parts affected, must be combined, if possible, with free incisions to allow of the escape of the unhealthy material depositing along the course of the vessels. But enough has been said in treating of erysipelas and of pyæmia, to render it unnecessary to enter here into details of management, which would be merely a repetition of those recommended for the aforesaid diseases.

In cases of diffuse suppuration, the coagula play an unimportant part, very different from that which they occupy in cases of clot-obstruction (more especially when they soften and acquire the puriform condition). Enough has been said to show the great difference between the two affections; but unlike as are the two diseases, they have this in common, that either may be the cause of those secondary complications to which the term pyæmia is properly restricted.

Infants occasionally suffer from inflammation about the umbilical vein, as noticed by Osiander, Meckel, and by Duplay.* It commences from the second to the twelfth day, and is often preceded by some injury which the child has sustained. In other cases, it would seem to depend upon influences

* *Revue médicale*, 1838, tome iii. p. 104. See also Morgagni, *Epist. Anat. Med.* liii. art. 37.

the same as those causing puerperal fever and allied disorders. Duplay found in three out of six cases that erysipelas was associated with the affection of the cord; and occasionally even local gangrene occurs, thus showing the low phlegmonous character of the affection. The general bad condition of the children is also indicated by discharges from the mucous membranes, and by the co-occurrence of purulent ophthalmia. Death occurs from the twelfth to the sixteenth day. The entire cord is involved, thickened, with the structures around, and often with peritonitis. The umbilical vessels are all obliterated in the common affection, their canals being filled with clots, which have been found to extend into the portal veins. The diet of the child and the various secretions require attending to, and warm fomentations may be applied to the inflamed structures; but the tender age of the infant is unequal to resist so serious a disease, for a fatal result has followed in all recorded cases.

Some veins not infrequently contain loose *calculi* or phlebolithes, generally round or oval, and sometimes attached by a narrow pedicle to the inner wall. No inconvenience results from their presence. They are found most frequently in the veins of the pelvis about the bladder and prostate, especially when the latter is enlarged.

Their origin has been much questioned. Bichat* thought that they occurred in veins exposed to slow circulation of their contents. Hasse found them connected with varices. Hodgson† held that they were probably formed in surrounding parts, and made their way into the veins by absorption. Cruveilhier stated that they were developed in the centre of a clot of blood. It is, however, most probable that they are clots which have thus dried up and become transformed. Having protruded from some small branch, they receive additions to their surface, and, eventually separating from the pedicle which held them to their original vessel, shift their situation, and are perhaps rolled along for some distance by the blood-stream before being finally arrested.

They are formed of concentric layers, which consist, according to an analysis kindly made for me by my friend and colleague Dr. Frankland, of protein matters and phosphate of

* *Anat. gén.*, par Bécclard, p. 104.

† *Dis. of Arteries*, p. 511.

lime. The former, constituting about twenty per cent. of the calculi, are nearly all albuminous or fibrinous; the latter, though mainly phosphate of lime, is mingled with a little sulphate of potash and sulphate of lime. That is to say, the phlebolithes consist, as might be expected, of the coagulated protein constituents and the less soluble salts of the blood.

HYPERTROPHY AND ATROPHY.

Hypertrophy of veins occurs when any part of the body is the seat of increased growth. It is a natural and healthy change. Thus during pregnancy the uterus is provided with enlarged channels for the removal of its venous blood; and thus in a case of medullary cancer of the omentum I have seen the portal vein twice its natural size, in consequence of the large quantity of blood carried to it from the rapidly-growing tumour.

With this form of hypertrophy there is proportionate dilatation, so that the vessels are perfect to perform all their functions. They are thus adapted to new conditions, as when an artery is wounded through a vein, and the latter dilates (aneurismal varix) above and below, its walls becoming thickened so as to resist the arterial impulse.

Hypertrophy with dilatation also compensates for many obstructions to the circulation by fitting one set of veins to make up for the loss of any other. Thus no inconvenience follows when superficial veins are obliterated, for by dilatation of anastomosing branches the circulation is readily re-established. When the vena cava inferior even is permanently closed, it is well known that the lower portion of the vessel dilates in common with the branches opening into it; that various small veins become large—for example, the superficial abdominal or azygos major*—and so carry to the heart the blood which ought to have reached the right auricle by the usual channel. Such cases have been long on record. One, described by Halford, is preserved at the College of Surgeons, and shows the iliac vein slightly dilated below an obstructing coagulum, a varicose (dilated) set of veins about the groins having carried on the circulation for several years before death.† This kind of dilatation ceases when the veins can conveniently carry the extra

* Museum, Guy's Hospital, 1521³².

† Museum, 1732. See cases by Morgagni, Portal, Petit, Cline, and others; also Reynaud, in the *Journal hebdomadaire*, tome ii. Paris, 1829.

quantity of blood, and the change is permanent or temporary as the obstruction remains or is removed, for in the latter case the veins usually regain their ordinary size.

The only anatomical change which attends this increase of a vein is the addition of transverse fibres to its middle coat; its length is unaltered, and its walls remain smooth and uniform, save where pouches behind the valves account for slight irregularities; but as noticed by Baillie and Watson,* 'the vessels are often bent and twisted when the current forces its way backward against the opposing but ineffectual barrier of the valves.'

If the obstruction to the circulation is in the heart, or in the lungs, that is to say, in one of the central organs through which all blood must pass, no round-about channels can rearrange the circulation. The veins still dilate, but the change is passive, and accommodates them to the blood which accumulates within their canals, because its onward passage is impeded. Thus it happens, with obstruction from disease of one of the valves of the heart, that the entire venous system dilates, so that veins which can be seen, such as the external jugular, are turgid and distended. Maybe, with this dilatation, there is proportionate strengthening of the vein-wall; but it more commonly happens that the yielding is simply passive, increasing until relieved by rupture of the wall (hæmorrhage), or by exudation of serum (anasarca).

Atrophy of veins, in common with atrophy of other structures, naturally follows disuse of a part. After amputation above the knee, the femoral vein lessens to one-third of its previous size; after removal of a testicle, the corresponding spermatic veins shrink and waste. In a case in which the right kidney had been transformed into a large cyst from the impaction of a calculus in its ureter, the canal of the renal vein would not admit an ordinary-sized probe.

Degeneration of the coats of a vein never associates with atrophy of the vessel; indeed, its rarity under any circumstances offers a marked contrast to its frequent occurrence in arteries. In the museum of St. George's Hospital,† a vein from

* Museum, Middlesex Hospital, series vi. 32°. *Trans. of a Society for the Improvement of Med. and Chir. Knowledge*, vol. i. p. 127.

† Series vi. 191.

the broad ligament of the uterus contains a round white mass within its tunics, the vein being pervious; in another case,* a calcareous deposit involves the internal saphena; and Baillie mentions a case where a similar deposit was found in the coats of the vena cava inferior, near its division into the common iliaes. Béclard observed calcareous degeneration in the femoral vein, and Macartney and Andral in the internal saphena. It has also been met with in the hepatic veins;† but its occurrence may be considered accidental wherever situated. Indeed it is doubtful if these calcareous plates should be regarded as a degeneration of the vein-wall; it is more probable that they depend upon an after change in some local deposit of fibrine.

VARICOSE VEINS.

Varicose veins. *Varix.* ‡ *Phlebectasis.*—When a vein becomes dilated without any good object or purpose, it is said to be varicose. In the active or passive dilatations already described, which adapt these vessels to certain states of the circulation, the purpose is as evident as is the gain which results. Not so with varices. No good comes from them. They are useless and hurtful.

Many of the early medical writers were familiar with much that is at present known respecting varix. It is still the ‘dilatation of a vein’ described by Paulus Ægineta;§ and our treatment of the dilated vessel continues practically unchanged. Some veins, so far as is known, are unaffected by varices, while among those which have been reckoned as varicose a considerable number ought rather to be referred to that hypertrophy with dilatation which has been already described. Thus the tumours formed of tortuous and dilated subcutaneous veins (fancifully likened by Severinus|| to the head of Medusa), which occasionally occupy the hypogastric region, simply compensate for the obstruction of some large vessel, such as the vena cava inferior, unless indeed they are due to that congenital communication in rare cases maintained between the portal system and

* Museum, St. Thomas's Hospital, γ, 170.

† Museum, College of Surgeons, 1438.

‡ *Varius*, unequal. Græcis κῑστός aut ἕξια Hippocratis dicitur.

§ ‘Varix venæ dilatatio est, aliquando in temporibus, aliquando in una ventris parte, sub umbilico, nonnunquam etiam circa testiculos, sed maxime in cruribus’—*Opus de Re Medicâ*, Lat. don. p. 50. Paris, 1532.

|| M. A. Severinus, *De recond. Abs. Naturâ*, cap. ix. § 13.

subcutaneous vessels of the abdomen by means of a patent umbilical vein, and of which a few instances are on record.*

True *varices* are commonly met with in the submucous veins of the bladder and rectum (hæmorrhoids),† in the spermatic veins (varicocele, cirsocele),‡ and in the veins of the lower extremities. They are also, though rarely, met with in the veins about the face; more especially those of the lips and eyelids. In one specimen they may be seen involving the internal jugular; § in another, the veins of the stomach; || and they are said to affect the pharynx, œsophagus, and small intestine, but of these the records are unsatisfactory. One case of varix at the bend of the elbow is recorded by Petit; and a boy is stated by Warren to have suffered from varix which formed between the shoulder and elbow after violent muscular exertion; ¶ but phlebectasis of the upper extremities is a very rare occurrence.**

Varices of the *lower extremities*, though much had been written respecting them, received but little attention from anatomists. This neglect occasioned and maintained the error of Boyer, adopted by most of those who wrote upon the subject, that varices are an unnatural permanent dilatation of the *subcutaneous* veins, from which the *deep* veins are at first exempt, and that the latter, constantly sustained by the muscles, receive from these contractile organs a support by which they escape dilatation, whilst the subcutaneous, less well supported, can expand indefinitely.†† The disease, limited in its origin to one set of vessels, was said to be caused by a retrograde movement of the blood, or by a mechanical obstacle to the return of the blood of the heart, or by a communication between the arteries

* Cruveilhier, *Anat. path.* liv. xvi. pl. 6.

† See DISEASES OF THE RECTUM.

‡ See DISEASES OF THE MALE ORGANS OF GENERATION.

§ Museum, St. Thomas's Hospital, x, 155.

|| Museum, College of Surgeons, 1158.

¶ *Traité des Maladies chir.* tome ii. p. 49; *Surgical Observ. on Tumours*, p. 432.

** An interesting preparation in the Museum of St. George's Hospital, series vi. 242, shows all the deep veins of the arm varicose. The clusters of veins surrounding the main artery received an obscure pulsation from it, and there was much difficulty in determining the nature of the affection. It was noticed to come on after striking a violent blow.

†† Boyer, *Traité des Maladies chir.* tome ii. p. 451; Sir Everard Home, *Practical Observations*.

and veins, small vessels passing directly from the one to the other. The last suggestion, however attractive in theory, failed from the absence of anatomical proof, for the presence of the anastomosing vessels has never been shown by dissection.*

The error of Boyer's doctrine rested upon insufficient anatomical research; for in fact varices do not invariably commence in the trunk of the saphena, or in that of any superficial vein. The seat of varices, as shown by Verneuil,† is as often in the deep veins, and they thence extend to the subcutaneous vessels by the numerous anastomoses existing between the two sets; and far from being rare, the deep varices are of very frequent occurrence.

There are various veins in the thickness of a limb: some deeply seated in company with the great arteries, the popliteal, posterior tibial, and the like; some which lie in the subcutaneous tissue; and lastly, intramuscular veins, which convey blood from the muscles to the deep or superficial vessels, and form anastomoses between them. These intramuscular veins carry large quantities of blood, and their capacity is great in proportion. I find that the six principal veins which pass in the adult male from the soleus muscle to the peroneal and posterior tibial vessels, have a united diameter of not less than an inch. Where these vessels open into the deep veins (more especially

FIG. 154.



the peroneal and posterior tibial) the latter are often greatly dilated, as may be seen by the accompanying diagram, which indicates their condition in a case of varix which I examined in a body brought to St. Bartholomew's for dissection. Broca, quoted by Verneuil, found deep varices equally with the subcutaneous; Denucé observed that they were less rare than had

* Pigeaux, *Traité pratique des Maladies des Vaisseaux*. Paris, 1843.

† *Gazette médicale*, 1855. *Gazette hebdomadaire*, 1861, p. 428.

been supposed, and existed even when the subcutaneous veins were unaffected; Deville and Fouché, their attention being called to the subject, confirm his statements; and Dumay communicates a case in which, whilst tying the peroneal artery, it was found to be surrounded by large varicose veins with extremely thin walls.

According to Verneuil, the intramuscular veins also become varicose, and specimens are preserved in the Musée Dupuytren* to show they are sometimes affected without change in the subcutaneous. In my dissections I have failed to meet with this intramuscular varix;† but from the examination of bodies brought for dissection, in which varices are occasionally discovered, and in which the vessels have been carefully traced, I can confirm the statement of Briquet, that at the spot where varices are most common, large trunks communicate through the muscles with the deep veins; and I find the latter as commonly diseased as the superficial vessels, the disease being most advanced where the intramuscular veins empty their blood into either set.

Causes.—Certain conditions of system favour the formation of varices, congenital predisposition amongst others; a disposition thought by some to be hereditary. Very little is known about it. Persons with an indolent temperament, or persons reduced in health,‡ suffer from a relaxed and debilitated condition of the vein-walls, which lose their tone and their elasticity, and then offer little resistance to the pressure of the blood. In some cases, the heart's action is reduced in frequency (I have seen young adults in whom it beat but forty times in the minute) and in force, so that it slowly and with difficulty relieves itself of the venous blood. Such people, and others to a less extent, are more likely to suffer from varix if their occupation is one which habitually involves much standing or walking—in fact, any long-continued muscular exertion; and so cooks and grenadiers have been selected by Brodie and by Home as especially prone to the formation of varicose veins. They are developed chiefly during the active middle period of life; but their appearance may be postponed until old age, or may be

* Specimens 254, 259.

† Further investigations confirm me in this statement. The various opinions on this and other points in the anatomy of varix are fully discussed in chap. i. of Mr. Gay's work *On Varicose Disease*. London, 1868.

‡ On the influence of gout, see Paget, *St. Bartholomew's Hospital Reports*, vol. ii.

referred to early life, since they not unfrequently occur in children under ten years of age.

Obstruction to the circulation is a passive aid to their formation. Hence they coincide with certain diseases of the heart, of the lungs, with cirrhotic liver, and are common when the portal system is overcharged with blood, as with those who *live well*, though such suffer more especially from varices of the rectum (hæmorrhoids). Constipation involving the accumulation of fæces in the intestine and pressure upon the iliac veins, the obstruction of veins with clots, the pressure of tumours, and such artificial pressure as that of an ill-adapted hernia truss or tight garters, may be enumerated as examples of conditions which retard the circulation, distend the veins, and prepare them to become varicose.

Such conditions have more influence upon the veins of the leg, because the pressure of the column of blood which these vessels have to resist is increased by gravitation. Although the column of venous blood ascending against its own weight, is supported by the column of arterial blood, yet the pressure of the fluid upon the walls of the veins increases by gravitation, inch by inch, towards the most dependent portions of the body. To illustrate this fact, the small intestine, freed from its mesentery, may be held so that its upper and lower outlets are upon the same level, the intermediate curve being pendent. If its canal is filled with water, it is easy to compare the lax condition of its walls above with their tension, almost to bursting, at the curve below. In the veins this tension is relieved by valves, and some dilatation is permitted, as occasion requires, by their thin and yielding walls; but when the occasion passes by, the elastic vessels soon recover their natural capacity, and then the slightest force acting upon the blood-column tends to quicken its movement through the venous system. If there exist a tendency to dilatation by obstruction, such force, instead of moving the blood-column, is expended upon the vein-walls:* and if the force is represented by a certain quantity of blood forced into a vein, then there is added an increased tendency to dilatation by excess of contents.

In persons with relaxed and debilitated veins the varicose condition would seem to be determined by the habitual *over exercise of muscles*, especially those of the calf of the leg, which

* See experiments by Williams, *Principles of Medicine*, 2nd edit. p. 188.

force the blood violently into vessels inclined to yield to the distention, and already over-filled by reason of a retarded or obstructed circulation. The dilatation which ensues is usually of slow progress; indeed, for a time the veins are often increased in thickness and strength to resist this distention; but Paré records cases, and his observations are confirmed, in which large varices have suddenly appeared after violent muscular exertion,* such as running, dancing, or carrying heavy weights. Wherever, so far as superficial varices are concerned, the intramuscular veins pass into the subcutaneous, there the varix is first noticed; there the force, that is the blood-stream impelled from the muscles, tends to act on the vein-wall and to dilate the vessel; for the valves obstruct below, and the column of obstructed slow-moving blood resists above.†

The *anatomical changes* in varicose veins have been described by Andral; and his distinctions, though too minute, have been generally adopted.‡ In brief, it is sufficient to notice, that the coats of the dilated vessels may become thickened, or may become thin; that they may be lengthened, so that the veins are rendered tortuous; that the dilatation may be unequal, the vein being marked with pouches, which form at the sinus behind each valve, or result from the greater yielding of the vessel where the blood is forced into it from an intramuscular branch; that varix of the femoral vein, which occasionally requires to be distinguished from a femoral hernia,§ is thus formed by yielding of the vessel at its junction with the internal circumflex, saphena, and profunda veins.

* Warren, op. cit. See also Malgaigne, *Œuvres compl.* t. ii. p. 268.

† Mr. Gay has elaborately considered the question of the cause of varicosity (see op. cit.). So far as I can judge it seems desirable to assign as causes those mentioned in the text, especially the influence exercised by the intramuscular veins upon the deep and subcutaneous systems of veins in the lower extremities.

‡ Varices: species 1. Simple dilatation, affecting the whole length of a vein, or existing only at intervals. 2. Simple dilatation, with thinning of the parietes. 3. Uniform dilatation, with thickening of the parietes. 4. Dilatation at intervals, with thickening at the dilated points; in this, and in the third species, the vessel being lengthened as well as dilated. 5. Dilatation, with the formation of septa, which divide the interior of the varix into many compartments, in which the blood coagulates. 6. The addition to the last of many small apertures in the walls, allowing the escape of blood, as in erectile tumours.—*Pathological Anatomy*, Eng. Trans. vol. ii. p. 4 et seq. Dublin, 1831.

§ See HERNIA.

As the vein-canal dilates, the valves, unless previously ruptured by violent and sudden muscular action, are unequal to close the passage; and, being useless, they presently waste and are reduced to mere fibrous bands, or disappear altogether.* The valves are not destroyed by the backward pressure of the column of blood obstructed in its passage to the heart; for they are adapted, as is well known, to resist this pressure, and they become, when needful, thick and strong, to fit them for doing so. But the force represented by the stream of blood advancing from below, and from the intramuscular veins, presses upon their rear, and, as they are unable to resist a force acting in this direction, flattens their cusps against the vein-wall; and there, when the vein, from the combined action of several causes, has become so large that the valve-cusps are unable to meet and close its canal, they shrink and atrophy. It follows that, in varices, those valves only are thus destroyed which lie between the lowest varix and the heart; and, when they are destroyed, that the pressure of the blood-column, which they helped to resist, weighs more heavily upon the dependent and dilated vessels.

The tissues which surround the diseased veins become gradually absorbed in consequence of the continued pressure of the varix, and thus, as noticed by Hodgson,† bones even become indented. So thin, indeed, may the coverings of a varix become, that, with sudden exertion, or from a blow, they rupture, and hæmorrhage ensues. In cases of long standing, however, it is usual to find the neighbouring structures thickened and hard from simple œdema, or from inflammatory exudation, which, by involving the neighbouring lymphatics, causes many of them to be permanently obstructed; so that, what with their obstruction and the obstructed vein-circulation, the whole leg becomes œdematous, and in time accumulates a great superfluity of fibro-cellular tissue, a condition which in severe cases is recognised as the Arabian elephantiasis.‡

Varices of the lower extremity do not affect especially the left limb. The curious error which long prevailed, and gave

* Museums, Coll. of Surgeons, 1736, and Bartholomew's Hospital, series xiii. 79. Gay is of opinion, 'As a rule, veins that become varicose are destitute of valves; and the cords which have been supposed to testify to their existence in these veins are referable to another source, viz. blood clot.'—Op. cit. p. 105.

† Op. cit. p. 561.

‡ For erectile tumours, and their relations to varices, see NÆVI.

precedence to the left leg, has been completely exposed. Statistics obtained by Verneuil, from cases observed at the Hôtel Dieu, show that one limb is diseased just as often as the other. In fact the cases are rare, if they ever occur, in which the disorder does not affect both limbs simultaneously, although the greater progress in the superficial veins, which is observed in one limb, commonly causes the condition of its fellow to be passed by unnoticed.

Symptoms.—Though varices may exist for a long time, and cause little, if any, inconvenience, yet it is more usual for those who suffer from them to complain, some time before the external manifestation of the disease, of aching pain, deep seated in the limbs, with sense of weight, fulness, and fatigue, in some cases complicated with a certain numbness and even loss of power in the extremities. In a more advanced stage of the disease, the ankles swell after a hard day's work, and the feet are constantly cold. These symptoms indicate an embarrassed state of the circulation, to which is gradually added dilatation of the deep-seated veins, and more especially of the posterior tibial.

After a time, at one or more points in the leg, a small tumour, in an early stage resembling the 'venosité' of Briquet, is formed, soft, of a bluish colour, from the dark blood showing through the integument; it disappears on pressure, but returns when the pressure is removed, or when the patient stands up, and is caused by a vein which is dilating where joined by an intramuscular branch. Around this tumour a series of minute vessels are clustered of a dark, bluish colour—the small superficial veins through which the passage of the blood is retarded to a greater degree than elsewhere, because they open directly into that part of the vessel which is dilating. By degrees the dilatation extends and involves an increasing length of vein, and then forms irregular, knotty, convoluted tumours, soft and diminished in size by the horizontal posture, giving a bluish tint to the skin, which is stretched and thin, and surrounded by smaller veins, also somewhat varicose. These tumours are grouped around the points at which the dilatation first commenced, for the most part in the middle of the leg along the track of the external and internal saphena veins, but the clusters of tortuous vessels often extend along the entire length of the leg and thigh. To the symptoms already enumerated

there is often added an unpleasant itching; and when nerve-fibrils are by chance involved, a sharp tingling pain.

Occasionally, when the varices gradually thin the skin which covers them, and burst through it, hæmorrhage ensues, which may cause syncope and even death if not promptly arrested; for the valves being destroyed between the varix and the heart, the escape of blood is directly from the proximal portion of the vessel, and may be very considerable. In treating such a bleeding, the patient should be promptly laid on the ground, and the leg should be raised, when the hæmorrhage will probably cease. If it continue, the pressure of a pad of lint applied to the bleeding vessel, and secured by a few turns of a bandage, will effectually arrest it.

In inflammation of the tissues around the veins we have the prelude to irritable conditions of the skin and eczema, to obstruction of the absorbents, and to ulceration;* and when the vein-walls from the same cause become surrounded with lymph, the condition is reached in which, as previously described, the vessels become filled with clots and obstructed. The knotty tumours are then hard and cannot be emptied by pressure, and this consolidation is permanent, for varicose veins once obstructed with clots never have their canals reopened. In this way the natural cure of a varicose cluster is often effected, with much temporary relief to the patient: as, however, the predisposition continues, and the exciting cause remains, other adjacent veins soon become involved, and perpetuate the disease.†

Treatment.—Varices of long standing are inveterate; for although much may be done for their relief, they cannot be cured; and hence it is fortunate, although they occasion the patient much hurt and inconvenience, that they are not serious in their consequences. In their earlier stages they are more manageable; and it is much to be regretted that early symptoms are mostly unheeded, for whilst the disease is limited to the deep veins, or at most has involved but slightly the superficial vessels, it admits very readily of permanent benefit.

The management of the general health is an important item in the treatment of varices in every stage. The feeble and often ill-nourished patients who suffer from this disease, must be in-

* For varicose ulcers, see vol. i. p. 199.

† See cases by Hodgson, op. cit. p. 561.

vigorated by tonics and a generous diet. The plethoric patient, with an embarrassed portal circulation, will gain much from often-repeated but small doses of purgative medicine, and by the use of cold saline baths. In each case some special symptoms will probably demand attention, and must be met by appropriate remedies; but in the large class of cases in which there exists a constitutional or acquired laxity of the veins, no remedy equals the tincture of the perchloride of iron, with an aperient pill every other night to obviate the occurrence of constipation. Under its influence, combined with proper local appliances, the laxity of the veins disappears, and the varices, if recent, are disposed of.

Provided always that the disease is not of long standing, and that local causes of obstruction, such as tight garters, are done away with, it is advisable, with this general treatment, that the legs should be rested in the horizontal position for at least a month or six weeks. Walking should be prohibited, and only carriage exercise allowed. The limbs, thus rested, should be bandaged from the toes to above the knee, the pressure being firm and equal, and the bandage (Domett) should be renewed daily. At the time of each renewal the limb should be well rubbed with the hand for about a quarter of an hour; by this treatment the circulation through the subcutaneous veins is rendered brisk, and the tonicity of the walls by degrees re-established. What with the inaction of the muscles, the improved tone of the superficial vessels, and the amendment of the general health, a good result may be anticipated.

But patients seldom have the inclination or the opportunity for submitting to such rigid treatment for the cure of a disease which causes comparatively little inconvenience; and when this is the case simple compression of the distended veins will often give great relief, and even prevent the disease from growing worse. Sufficient support may be obtained by merely bandaging the limb, greater pressure being made over the larger of the varicose clusters than elsewhere by means of a pad of lint placed upon each of them before the bandage is applied.* Elastic spiral bandages, or the elastic web stockings, are recommended as conveniently supplying the necessary support. They should be removed at night when the patient goes to bed, and replaced

* Local compression was first recommended by Delpech and Sanson. See Delpech, *Maladies chir*, tome iii.

when he gets up in the morning. If any one of them causes irritation of the skin, it must be changed for some other; and it will often be found useful to protect the integument by means of flannel bandage or cotton wool before these appliances are put on. The most difficult to manage are the old varices surrounded by a quantity of indurated tissue, which protects them from ordinary pressure; the difficulty may generally be overcome by the exercise of a little ingenuity in applying the supports. Travers cured a varicose cyst of the saphena by the pressure of strips of plaster. The varix should be emptied of its blood, and the strips, of a convenient length and breadth, should be then applied, crossing one another at right angles. A firm and even pressure may also be obtained by applying a wet bandage. A number of pieces of muslin, linen, or calico are prepared, each about two inches wide and twelve inches long, and saturated with water. Two of these strips are first placed beneath the foot, and their ends crossed over the instep towards the ankle. Other strips are then bound round the leg, their ends crossing in front, so arranged that the one above half-covers the one below, until the limb has been bandaged to a sufficient height. An ordinary roller is then placed over all, and each day the application is renewed.

These measures are, however, simply palliative; and in the desire to effect the cure of so common, and often troublesome a disease, many devices have, from time to time, been employed. With the exception of Herapath's suggestion for dividing the fascia lata at the saphenous opening to relieve a supposed pressure upon the femoral vein, they all aim at procuring obliteration of the varix, or of the chief vein connected with it. But from all these measures it is quite certain that only a temporary benefit is obtained; for after one mass of varices has been removed, the anastomosing veins around soon acquire a varicose condition, and the disease is perpetuated. In deciding upon performing any one of the many operations open to choose from, it must be the relief, not the cure, of the varix which is anticipated; and no doubt there are cases, yet not so many as some would have us to believe, in which the pain of the varix, the impossibility of healing a large ulcer, the unfitting of a patient for his every-day work, justify the operation for the sake of the temporary benefit.

It has been objected to these operations, that they have sometimes imperilled the patient's life, and at one time they were

brought into disrepute by the occurrence of several deaths from diffused inflammation extending along the course of the vein which had been operated upon; but the objection should be made, not to the operation, but to the performance of it upon patients in a bad state of health, who, to avail oneself of the quaint language of Dionis, are opprest with humours always ready to cast themselves upon any one locality.* If the cases are selected with care, the judgment which decides in favour of an operation will never be reproached by the occurrence of serious hurt to the patient; and the only troublesome consequence will be a languid condition of the wounds, which, from the indolent circulation through the limb, are, as stated by Skey, often very difficult to heal.

The operations recommended for the local relief of varices are modifications of one another. Their practice dates from the earliest record of surgery, and some curious peculiarities of treatment may be referred to as showing the uncertain reasoning which regulated it. Thus, Celsus drew a distinction between straight and convoluted varices; for the first he recommends† that they should be exposed by cutting through the skin, and then destroyed by the actual cautery; whilst the latter he at once cut out with the knife. Ambroise Paré and Petit‡ punctured them, squeezed out their contents, and then applied a compress; but when the blood stagnated in an isolated tumour, they cut down upon and removed it. But, says Paré, old varices should be left alone, lest, being removed, the patient should be suffocated. Boyer followed Paré, but tied the vein above and below before opening it; and Home, after dividing the skin, passed a thread under the vein, and so tied the vessel leading from the varix towards the heart, under the impression that the blood, as it could no longer flow through the vessel, would stagnate, and then coagulate: and in practice Home found that varicose ulcers were thus more readily healed. From what has been here said respecting the causes of varicose veins, it is evident that no good could follow this operation; indeed, any benefit that patients obtained from its performance was probably due to the rest which it necessitated.

Amongst other suggestions, Fricke advised that two or three

* 'Cocochymes et accablés d'humeurs, toujours prêtes à se jeter sur quelque partie.'

† *De Re Medicâ*, lib. vii. cap. xxxi.

‡ *Traité des Maladies chirurgicales*, tome ii. p. 64.

threads should be passed through the vein, after the fashion of a seton; and Capaletti* employed galvano-puncture to induce clotting of the blood within the varix; whilst Graefet† actually opened the vessels and filled their canals with lint. But all these methods were employed without any fixed idea of what was to be accomplished by their means.

Our object is now more definite, as we seek to relieve for a time this varicose condition by causing coagulation of the blood within the dilated veins, which then shrink and contract permanently. This result can be attained, 1st, by the action of caustics applied over the course of the vessel; 2nd, by subcutaneous division of its walls; 3rd, by compressing it between a steel pin and a twisted suture, or by some similar contrivance. The potassa fusa, or Vienna paste,‡ may be applied as recommended by Mayo, in quantity sufficient to cause sloughing of the skin over a varix, or the venous trunk connected with it. The tissues beneath the slough inflame, the vessel is filled with coagula, and so becomes obliterated. The slough should not exceed a quarter of an inch in its diameter, and the surrounding skin should be protected from the action of the caustic by a ring of plaster encircling the portion to be destroyed. Brodie recommends that sufficient caustic shall be employed to insure sloughing of the vein, as a more certain mode of securing its destruction, the vessel becoming closed and contracted above and below the slough. According to circumstances, two or more of these sloughs will be required, and in making them they must be carefully kept some distance asunder. Whether the varix is thus itself destroyed, or the venous track which passes from it, the blood which formerly passed through these vessels is driven into other channels, which gradually dilate into a fresh crop of varices.

Subcutaneous division of varicose veins is easily performed by means of a narrow pointed bistoury, first employed by Brodie,§ which is introduced between the skin and the vein, and is made to divide the latter as it is withdrawn. A compress of lint should

* See *Archives générales*, 1848, p. 228.

† C. Bell's *Surgery*, German Trans., preface.

‡ Composed of five parts of quick-lime and four of caustic potash, made into a paste with spirits of wine immediately before its application. Nitric acid may be substituted when it is only required to excite inflammation about the vein.

§ *Lectures on Pathology and Surgery*, p. 185.

be at once applied to restrain hæmorrhage. This operation has the advantage of leaving a wound which heals readily, often by the first intention; but in some cases suppuration has followed, and in some it has failed to obliterate the vessel; so that, says Brodie, 'it really appears it is not worth patients' while to submit to it. I have always observed, that if I cured one cluster, two smaller ones appeared, one on each side; and that ultimately I left the patient no better than I found him.' If this operation is performed to facilitate the healing of a varicose ulcer, the vessel should be divided, if possible, below, so as to interrupt the blood as it streams in from anastomosing vessels and causes the distention of the veins about the ulcer. After this or any similar operation, the patient must be kept quiet in bed for at least four or five days, and longer if necessary.

Velpéau, following Davat, employed a metal pin, which he passed under (never through*) the vein, and on which he applied a twisted suture. The pin was allowed to remain in until sufficient inflammation had been excited to promote obliteration of the vein; but when the irritation which followed was but slight, the pin was left to come away by ulceration of the structures which covered it. Some of these pins he applied to the varicose clusters, and some to the veins communicating with them; and as no very bad results followed his operation, it was pretty generally tested. But, like others, it affords only temporary relief; and besides is open to the objection that the sores which result are often difficult to heal, although this is an objection more especially to the treatment by caustics. To prevent sloughing of the integument, it is recommended by some surgeons to protect it from the twisted thread by means of a piece of wax bougie. Various other devices for conveniently securing the obliteration, have from time to time been suggested.† A good and expeditious plan is that recommended by H. Lee, by whom it is thus described: 'A needle is introduced beneath the vein or veins to be obliterated, and an 8-ligature is passed over its extremities. The vein or cluster of veins is thus included between the needle, which is below it, and the ligature, which is over the skin. The ligature is then tied so as to produce a

* Transfixing the vein and passing a thread through it, as proposed by Fricke, was found to occasion such great irritation that its use was presently abandoned.

† Metal pins for compressing veins are described in the *Medical Times and Gazette* vol ii 1861 p 377

slight degree of pressure on the vein, and by this means its cavity is temporarily closed by acupressure. Another needle is then passed under the vein at about an inch distance, and the vessel is there closed in like manner. The vein or cluster of veins thus included between the two needles is entirely separated from the rest of the circulating system, and may then be divided or otherwise obliterated without risk. Subcutaneous section of the vein is generally all that is necessary, and is preferable to any other mode of operating, as it effectually obliterates the vessels without leaving any open wound. At the expiration of about four days, when union is established in the divided parts, the needles are removed, having served their temporary purpose.*

Except in cases which have been referred to, these operations are not to be recommended; and the patient, if wise, will be content with the palliative measures of a more simple character.

I have several times referred to tumours as causing obstruction to the circulation of the blood through veins. Little inconvenience follows, in consequence of the ready formation of a collateral circulation. Some tumours compress veins against a resisting substance, as bone; some by their growth completely surround them; whilst others extend into their canals, as was first pointed out by Langstaff in a case of medullary cancer. In many instances they cause obliteration of the vessel by interruption of its canal and by absorption of its coats, or they induce the formation of clots, by which it becomes permanently obstructed. Now and then a tumour appears to have its origin in and to be confined to a vein, as happened in the splenic, as recorded by Hodgson, and in a case, related by Andral,* where the growth consisted of adipose tissue in the wall of a portal vein.†

A few words will dispose of the subject of worms and other

* *Op. cit.* vol. ii. p. 423.

† The following specimens give a good general idea of these vein obliterations. Middlesex, series vi. 32, 35: vena cava obliterated by pressure from an aneurism. St. Thomas's, γ , 171: vein filled with encephaloid deposit. Guy's, 1521⁶⁵: vena cava obliterated by the side of a dried-up hepatic abscess; and 1521⁹⁰, by pressure from enlarged glands. Guy's, 1522⁷ 15 25: growths of cancer into superior venæ cavæ. St. Bartholomew's, 13, 29: fleshy growth between vena cava and kidney, obliterating the former. Aneurisms and abscesses, though they sometimes burst into adjacent veins, may also cause obliteration: St. Bartholomew's, 13, 84; St. Thomas's, γ , 154; St. George's, vi. 128.

parasites which were formerly supposed to infest veins. The more exact and minute examinations of the present day have refused in this matter to confirm many of the statements of the past. Parasitic animals, except in the cases of migration of the embryo of *tænia*, and in the instances quoted below, are rarely found in these vessels.*

G. W. CALLENDER.

* Andral, Duval, Treutler, Fabricius, and Rudolphi, Virchow, and Leuckart, may be referred to. I find mentioned by one or other of these, *echinococcus altricipariens* and *distoma hepaticum* in the hepatic veins; *acephalocysts* in the pulmonary veins; *strongylus* and *filaria* in the veins of a horse; and *entozoa* belonging to the class *nematoidea* of Rudolphi in the right ventricle of a porpoise. *Hæmatozoa*, as they are termed, are said to be found in the veins of birds, reptiles, and fish, having perforated the vessels, as it is assumed, in their wanderings, and being then washed along the blood-stream until they stick in the capillaries. Leuckart, quoted by Küchenmeister (*Syd. Trans.* vol. i. p. 50), professes to have met on four occasions with the embryo of *tænia* migrating through the main branches of the *vena porta*. See also Siebold, *Syd. Trans.* p. 29.

The remarkable discoveries of Bilharz, Griesinger, Lautner, and others respecting the presence of small flukes (*Bilharzia hæmatobia*, Cobbold) should be referred to. They have been found in the portal system and in the veins of the mesentery and bladder. It is stated that in 363 autopsies 'Griesinger found this entozoon present no less than 117 times.' In advanced cases of the disease, as it occurs in Egypt and at the Cape of Good Hope, severe diarrhoea and hæmaturia precede death. Dr. Cobbold is so good as to inform me that he has discovered the same parasite in the portal blood of the *Cercopithecus fuliginosus*. The reader is referred for further details to Dr. T. Harley's paper in *Med.-Chir. Trans.* vol. xlvii.; or to Dr. Cobbold's treatise on *Entozoa*, p. 197 et seq.

DISEASES OF ARTERIES.

ARTERITIS.

THIS is a rare disease. The most distinct instance of a limited arterial inflammation is that of the umbilical arteries, which after the ligature of the funis are sometimes filled with pus.

Inflammation of the aorta appears to have occurred in the practice of some physicians, and to have been traceable to the influence of cold. One such instance mentioned to me by my colleague, Dr. Goodfellow, followed upon a young man's lying for a long time upon his chest on wet ground. But the cases formerly described by surgeons as primary inflammation of arteries appear, by the light of later research, to have been due to the previous impaction of a plug. Inflammation of an artery, and even suppuration, may then take place, but it is a secondary disease, and it will be referred to in the section on 'Occlusion of Arteries.' Upon the cases in which long portions of artery are found obliterated and converted into fibrous cords, it may suffice to say that no evidence of previous arteritis or of any cause whatever can be adduced, and that the same result without obvious inflammation attends the obliteration of the ductus arteriosus, and sometimes follows the application of a ligature.

The diseases of arteries besides inflammation are few, and they are but in part distinguishable by the anatomical division of the coats. The outer coat may be involved in diseases of the sheath and of the intervening connective tissue, but, though yielding to scirrhus, and being sometimes perforated by it, that coat long resists the encroachment of medullary cancer, which may grow around it and form a tunnel for the vessel. A new growth, described by Dr. Moxon under the name of Periangioma, is a rare instance of disease limited to the outer coat and sheath of arteries. It formed a tumour of the scalp, permeated by enlarged and tortuous vessels, and made up of

new material occupying uniformly their outermost and circum-vascular structures.*

Diseases of the middle coat are probably only secondary to those of the lining and external tunics of the vessel. The great hypertrophy of that coat, pointed out by Dr. G. Johnson, in the minuter vessels in cases of Bright's disease, or its dilatation in exophthalmic bronchocele, do not engage the special attention of the surgeon.

The most common disease of arteries is that of the inner coat, and it is of much importance in practical surgery, from its effects in weakening, enlarging, and occluding arteries.

ATHEROMA.

In the earliest stage of atheroma a thin, soft, and clear membrane lines a part or the whole of an arterial tube. It is at first scarcely distinguishable from the natural inner coat of the vessel; its free surface has the shining smoothness of that membrane, and as it acquires firmness and a closer union with the original internal coat, it furnishes, in fact, a new lining to the artery. This structure is added to the artery without the slightest appearance of disease in the original textures of the vessel. Its coats are neither infiltrated nor inflamed. There being no manifest cause in the artery itself for the formation of the new membrane, it may be looked upon as probably deposited upon the interior of the vessel from the blood.

This opinion as to its source is confirmed by the fact that the inner coats of an artery are devoid of nutrient blood-vessels, from which the new layer could be secreted, and by observing its further progress. On the inner surface of the new deposit a stratum similar to the first is laid, and, like it, becomes consolidated, firmly adherent, and in its turn the foundation of additional depositions. When many of these strata have thus accumulated within the vessel, the whole mass is no longer transparent, but becomes opaque, dull, and condensed into a material similar to hardened albumen, and eventually to ligament. The layer last deposited may still be often detected, thin, smooth, soft, translucent, overlapping the edge of the deeper mass, and possessing, both in appearance and on microscopic examination, the characters of a lining membrane.

* 'Periangeioma of Scalp; excision; recovery.' By Mr. Thomas Bryant. *Trans. of Path. Soc.* vol. xix. p. 376.

The coats of the artery are at first unchanged ; but as the deposit accumulates their function is abolished ; they waste, and lose their firmness, elasticity, and natural colour. The fibrous coat turns to a dull yellow hue and softens, and it may be easily stripped off. With its natural texture, it loses its contractile power ; it dilates, and is unequally thinned out, spaces being formed between its fibres, through which the deposit comes into contact and adhesion with the cellular coat of the vessel. The outer membrane at first becomes unnaturally vascular, swollen with infiltration, and manifestly inflamed. As the activity of this process subsides, it is converted into a callous, white membrane, closely adherent to the deposit and to the remnant of the middle coat.

One of two changes may occur in such an indurated lining plate of an artery. It may soften in its interior, or be converted into a layer of cretaceous matter.

Both the softening and the change into bone take place in the deeper parts of the deposit. In the former process it degenerates into a thick pulpy mass of cholesterine, oil globules, and albuminous and cretaceous molecules. The inner strata separate this pulp for a time from the blood ; but when they give way, the whole is gradually washed out into the stream, and the base of the cavity, composed of the weakened walls of the artery, is exposed to the impulse of the blood. The possible occurrence of an aneurism, particularly a dissecting aneurism, in this condition of the vessel will be evident.

Cretefaction, or ossification, likewise occurs only in a thick deposit, and in its external, oldest layers. The inner surface of a bony plate of an artery is for some time lined by the most recently laid stratum of membrane ; but if at length this also ossifies, the plate is exposed in the vessel. Externally, nothing intervenes between the plate and the middle coat, for the original lining membrane partakes in the chalky degeneration. The bony growth varies in its form in different specimens, and still more in different arteries. In the aorta, the innominata, and the common iliac, it assumes that of plates of different sizes, irregular in outline, generally concave and smooth internally, rugged and convex externally ; whilst in smaller arteries it grows in the shape of rings, which answer in their position and direction to the yellow circular fibres, and have been regarded as ossifications of that coat. In some of the larger arteries, a rough mass of bone may even project into the canal,

a growth of so peculiar an aspect as to be compared by Professor Rokitsky to stalactite.

The extent to which atheroma affects the system of blood-vessels is very various. In some instances, every artery sufficiently large to be named by anatomists is thus diseased; in others, certain vessels or parts of vessels are unaffected by it. Extensive atheroma of the aorta is almost invariably attended by disease of the other arteries; or, to state the same fact in the form in which it is usually presented to the surgeon, if the vessels of the limbs are found diseased, it may be presumed that those within the trunk are in a similar condition. It is necessary to note the instances in which the disease is limited.

The aorta may be diseased throughout, yet the coronary arteries may be healthy; and it is interesting to contrast the highly nourished state of the heart in such a case with its condition when its nutrient arteries are diseased. The aortic valves, the commencement or the whole of the arch, may be atheromatous, and no other vessel be affected. Isolated patches of the disease may occur between long tracts of healthy artery, and it is of the greatest importance in surgery to know this fact in relation to the popliteal and axillary arteries, of which short portions may be even ossified, while the femoral and subclavian, so far as concerns the possibility of their being successfully tied, are healthy. When at all advanced, the disease is found to be symmetrical, the arteries of opposite limbs being equally and similarly affected. This fact is well illustrated in the not unfrequent occurrence of parallel, almost contemporaneous, popliteal aneurisms in the same person. Some vessels are earlier, if not more frequently, affected with the disease than others. There is such a preponderance in the lower extremity over the upper, both in the proneness of its vessels to the disease, and in the degree which atheroma attains in the more distant limb. Some entire arteries rarely become atheromatous. Those of the stomach, liver, and intestines, are remarkably exempt from this affection, even though it may have attained an advanced degree in the splenic and the other arteries of the body. As a general rule, atheroma is a disease of the arterial trunks and larger branches, but it is occasionally met with in very small vessels. On one occasion, when making horizontal sections in the ordinary mode of examining a brain, I found all the minute vessels ascending through the central white matter of the cerebrum converted into stiff wires of bone, the first incision of

which blunted the knife. Haller once met with atheroma in the hypogastric artery, but it is the only case on record. The most marked exemption, however, is that of the venous system, including the pulmonary artery and its branches; and it is a very suggestive fact in reference to the causation of the whole disease. Atheroma, even its early stage, is rarely found in the vessels which carry venous blood; and when it does occur, it is associated with extensive disease in the aortic system.

So marked a difference in the liability of the two systems of vessels to this disease might seem to point to their structure as its cause, and lead to the error of regarding it as an affection of the middle coat of the arteries. But that a mere difference of structure cannot account for the exemption of the venous system is evident from the facts, that the contrast between the two systems is continued into the heart itself, that the deposit in cases of arterio-venous aneurism is at least as abundant in the vein as in the artery, and that it is readily formed within the pulmonary arteries, when a preternatural communication admits arterial blood from the left to the right side of the heart. It appears clear therefore that the source of the morbid material is arterial blood. It is further observed, that the disease prevails chiefly in persons who are in the decline of life, and is associated with a defective nutrition of the normal structures of the body, with arcus senilis, and with an accumulation of fat.

An attempt has been made to connect it with the inordinate use of alcohol; and there can be no question of its frequent, if not invariable, occurrence in drunkards. There must exist, however, some more hidden fault in the formation or purification of the blood, to which, rather than even to alcohol, the disease must be attributed. Young found calcareous concretions in the arteries of an infant; Wilson in a young child; and Andral in the aorta of a child of eight years of age. The latter author also met with ossific laminæ in the aorta in five or six persons of from eighteen to twenty-four years of age, and an extensive ossification of the superior mesenteric artery of a person not quite thirty.* Corfe records an instance of fatal aneurism, as arising from this disease, at the age of twenty-eight; † and in the Hunterian Museum, No. 1679, is a specimen of it in no alcohol-drinker, but in a jaguar. The gouty, the aged, the rheumatic, the persons whose tissues are imbued with fat, and those whose excretory organs fail to purify the circulating blood, are far more prone to the disease than the phthisical, the cancerous, or the young. Soldiers appear to be more than usually prone to atheroma, and consequently to aneurism. The arterial deposit is in them rather compact and leathery, and does not easily pass into the stages of softening or of ulceration. This form of disease is surmised to be one of the products of syphilis, which is apparently more than alcohol a source of blood disease in these otherwise healthy men.

* Copland, *Dict. Med.* vol. i. p. 119.

† *Physiognomy of Diseases*, p. 129.

The microscopic examination of the white and buff-coloured deposits shows them to be chiefly composed of granules and oil-globules. Mr. Gulliver first described them as containing cholesterine, oleine, and often some margarine.* Chemical investigations of the bony plates, by Dr. Bostock, proved them to contain 'a minute trace of albumen and gelatine, animal matter, much phosphate of lime, a little carbonate, and a trace of sulphate.'†

The atheromatous change in an artery is slow in its progress, and can only when far advanced be detected in the living subject. It is occasionally attended with persistent pain, which is liable to be mistaken for a rheumatic pain. When actually ossified, an artery which can be felt at all may be readily distinguished as thus diseased. In the radial, for instance, rings of chalky matter can be recognised as the finger is moved along the vessel. But attention is often first called to the state of the arteries rather by some secondary symptom of their disease than by the atheroma itself.

1. Atheroma is at first attended with a narrowing of the calibre of the vessel, in proportion to the thickness in which it is deposited. This is most marked at the bifurcation of trunks, and at the mouths of small vessels passing off from large trunks. In no spot is it more commonly observed than at the origins of the intercostal and similar arteries, which branch off at right angles from the aorta, and which are sometimes not only narrowed, but at last completely closed, by the accumulated deposit. Though the larger arteries are perhaps never obliterated by this process, yet even they may be much contracted by it. The canal of so large a vessel as the common iliac has been found diminished by one-half,‡ and the great ascending branches of the arch of the aorta nearly obliterated.

Of the latter occurrence, Dr. Yelloly recorded an instance. A man, aged fifty-six, who was supposed to be in health, but who had suddenly fainted two or three times in the two years preceding his death, fell and died while at work in his garden. The arch of the aorta was dilated and atheromatous, and the three great vessels ascending from its arch were in a considerable degree plugged up with a growth similar to the lining membrane of the artery, and without any bony deposit.§

A diminution of the size of branch-vessels from this cause

* *Med.-Chir. Trans.* vol. xxvi. p. 90. † *Ibid.* vol. xix. p. 87.

‡ Hunterian Museum, 1614.

§ *Med.-Chir. Trans.* vol. xii. p. 576.

may prove to be of serious importance in some cases, by hindering the establishment of a collateral circulation.

2. A later consequence of the disease is dilatation of the vessel. The outer coats being incapable of compressing the deposit, and closing in upon the blood after each cardiac systole, they fail to contract during the diastole, and the artery gradually expands. This enlargement is the most marked in those parts of the vessels through which the current of the blood is in any degree obstructed. All curved arteries, therefore, are disproportionately dilated. It is observed also in all parts at which an arterial trunk naturally widens in its course, and suffers in consequence a more forcible internal hydraulic pressure than the smaller tube which leads to it. The upper extremity of the common carotid is thus widened naturally, and dilated when atheromatous. In that situation, at the upper end of the innominata, and in the higher part of the femoral artery, the expanded vessel may claim attention as an aneurism.

3. The same mechanism which converts an artery into a fixed tube, incapable of contraction, but liable to dilatation, produces a similar effect upon its power of retraction. A healthy artery is in a state of longitudinal tension. It is, as it were, too short for the limb to which it belongs; and, if cut across, may shorten an inch or more.* Atheromatous and bony plates destroy this retractile power. But though incapable of shortening itself, the vessel may be lengthened by the repeated injections of blood along it. Arteries, therefore, in which atheroma has reached an advanced degree, become not only dilated, but also tortuous. The outline of brachial arteries thus affected may be seen in the bare arm, every pulsation of the heart increasing their curvatures. The common and external iliac arteries, too, bend far from their normal position, the former arching outward and forward between the aorta and external iliac, the latter leaving its place upon the psoas, and curving deeply into the pelvis in a new course.

* An artery *may* shorten to this extent. I have observed the ends of a torn brachial artery, in a boy of thirteen, to have separated more than an inch and a half when the elbow was extended. On the other hand, a cleanly divided healthy common femoral artery, preserved, with the adjacent structures, in the Hunterian Museum (No. 1568), has neither retracted nor contracted. The wound is stated to have caused fatal hæmorrhage. It may be remarked in explanation, that the brachial artery is very loosely connected with its sheath, and is not fixed by branches; while the common femoral is a short trunk, and rather intimately adherent to its sheath.

4. An ossified artery does not retain that smoothness of its interior which characterised the earlier deposition within it. In a large vessel like the aorta, a bony plate may crack across, or be lifted at its edge from the wall of the vessel; and the sharp rough projection thus exposed may cause the adhesion of fibrine. Strings and masses of this substance, as it accumulates, materially lessen the calibre of the vessel, or, being broken off, and carried along with the stream of blood, plug any smaller artery in which they happen to be arrested. The ossification of smaller trunks, as the femoral arteries, produces in another manner a roughness of their canal. The bony matter being thickest, or sometimes only existing in circular rings, the vessel is strongest at those parts, while it yields between them. The interior of such a vessel is consequently no longer smooth, but is formed of a succession of alternate transverse ridges and bays; the former answering to the rings of bone, and the latter to the expanded spaces between them. Such an artery resembles the interior of a piece of jejunum, into the canal of which folds of the valvulæ conniventes project; and the effect of the arrangement, just as in the bowel, must be to retard the current.

5. It has been already mentioned, that an atheromatous artery becomes dilated, and that it may yield and become aneurismal at a part from which the softened deposit on its interior has been washed away. It may be added, that the so-called ulcers of arteries, which are occasioned by the partial detachment or the cracking of calcareous deposits, 'are sometimes so deep as to reach, and even to perforate, the external or cellular tunic.'*

But, even without such previous detachment of its inner portion, a diseased artery may be torn through by the direct force of the blood. Dr. J. Risdon Bennett has recorded a case of sudden death, in which the aorta gave way before the impulse of a hypertrophied heart. The 'rupture was directly through all the coats of the artery; the edges of the aperture were somewhat ragged, and traversed a patch of atheroma.'† Messrs. James and Rose have published similar cases of spontaneous rupture of the aorta, and Mr. Arnott one of rupture of a diseased aorta from violence.‡

It is obvious that these accidents are the more liable to occur, as the disease is limited in extent. The artery yields at its one weak point.

* Hope, *Cycl. of Pract. Med.* vol. i. p. 145.

† *Med.-Chir. Trans.* vol. xxxii. p. 161.

‡ *London Med. and Phys. Journal*, vol. lviii. pp. 15, 19, and xviii.

6. In relation to accidents, and surgical operations on arteries, atheroma assumes a serious importance. No longer tense, mobile, elastic, these vessels become rigid, brittle, and fixed. A direct blow may crack or crush them; a severe wrench, or sudden unusual movement of a limb, may half break them; the violence which dislocates a bone may tear them in two, and give rise to a vast escape of blood. Mr. Syme alleges that he has known an axillary aneurism follow such accidents as the repeated sudden shock of a machine against the elbow, and a quick unguarded movement in lifting the arm to the head for the purpose of holding on the hat in a breeze.

When a ligature is tied upon an ossified artery, the sensation conveyed by crushing the bony tube betrays its condition. Sometimes the artery gives way. In the stump of a leg just amputated, I have seen an ossified tibial artery break three times under the ligature. The vessel was only secured at last by including a large quantity of the adjacent soft parts in the noose with it. In another case the ligature was wound several times round the artery. The difficulty experienced in safely tying such a vessel, has suggested the plan of dissecting along the artery, and placing the ligature on it higher up. As it is uncertain whether such an artery would be better adapted to bear a ligature in any higher part of its course, the safer plan seems to be that of securing it in the face of the stump. Such a case would be better treated by the ligature than by acupressure, but would be unfitted for torsion.

To atheroma and ossification are doubtless due the majority of the failures of operations for aneurism. Notoriously is this the case with the old operation, in which the artery was tied near the mouth of the aneurismal sac. And many times also, when the Hunterian operation has been adopted, the result has been disastrous from the same cause. The process of repair cannot be perfected in a tied artery, when the lining membrane is tough, or osseous, or in a state of fatty degeneration, when the middle coat is wasted, and the outer callous and attenuated, and when the rigid tube is incapable of contracting between the ligature and the next branch. From such an artery the ligature separates, perhaps earlier than from a healthy one, and hæmorrhage pours freely and fatally from one or both of its unclosed extremities. A prudent surgeon forbears from operating in such a case, or from tightening the ligature if he unexpectedly encounter a diseased vessel.

7. Gangrene may occur at different stages, and from various circumstances, in the course of atheroma; but, in itself, that disease is not capable of producing gangrene. For, so long as the vessels remain open, even though rigid, they allow blood to pass. And, in fact, any obstruction which may be occasioned by the roughness, is, to some extent, compensated for by the dilatation of their canal, and the distal parts obtain their nourishment. But should any unusual and considerable demand upon the circulation be made by a local injury or inflammation, the circulation will prove insufficient; and, as trees with tangled roots sometimes perish in a night upon a sudden increase in the rapidity of the flowing of the sap, the distal parts will die. Gangrene is often extensive when an ossified arterial trunk becomes occluded; and the explanation of the fact appears obvious. The collateral channels, through which alone the blood can reach the remoter parts, are themselves indurated or ossified, and are incapable of adapting their calibre to the larger stream which presses through them. The unnourished structures necessarily die. These occlusions of arterial trunks are not such as are very slowly completed by the accumulation of new matter at their orifices or bifurcations, but such as arise from the more rapid deposition of large masses of fibrine upon a rough part of an artery, or from the loosening and inversion of an osseous plate, or the washing of a detached cardiac vegetation down the current. The first, occurring comparatively early in the disease, can be made up for by the establishment of a collateral circulation; the others happen suddenly, in which case even healthy collateral arteries sometimes fail to preserve the life of a limb.

OCCLUSION OF ARTERIES.

Some other causes of obstruction to the current of blood remain to be noticed, besides those by atheroma.

There are persons who, by certain postures of their limbs, are able to stop the pulsation of their arteries. The radials and tibials cease to beat upon forcible flexion of the elbows and knees. Others can so depress the clavicle upon the subclavian artery, or raise that vessel by a forcible expiratory compression of the lungs, as to arrest circulation in the arm. Arteries displaced with fragments of bone are often without pulsation until the fracture is set. An exuberant osseous deposition around the fragments of a fractured bone may, it is alleged, compress

adjoining blood-vessels. The situation in which this has been observed to happen, is the fibrous canal in the adductor muscles of the thigh. I have myself seen such obstruction of the femoral, and gangrene of the limb, only where the artery itself was injured, or the fracture had not been replaced.

In like manner, that is to say by outward compression, morbid growths in the vicinity of blood-vessels enfeeble or stop the circulation. An exostosis once grew on the first rib in such a relation to the subclavian artery as to give rise to the symptoms of an aneurism of that vessel, and lead the surgeon who had charge of the case to tie the artery. Cancerous, and more rarely the innocent, tumours, compress and obliterate arterial trunks, which are found flattened, and either pervious or occluded with coagula or adherent fibrine. Even gangrene may follow the occlusion of an artery from this cause. This, however, is a rare event, as time elapses before the compression becomes complete, and blood, in some small quantity, continues to be driven through the flattened vessel. The obliteration of aneurismal vessels will be found explained at large in the essay on ANEURISM.

One other cause of the occlusion of an artery remains for consideration, that, namely, in which its canal is closed by an impacted foreign body. The cases are now numerous in which arteries have been found plugged by fragments of morbid growths, which have been detached from one part of the circulating system, and transported into some other part along the stream of blood. The plug which is found occluding the distal vessel has often no organic connection with its walls, and is detained in its place merely by having reached an artery too small to give it further passage. The accident is usually met with in the aortic system, and the most common situation from which such fragments are detached is the left side of the heart. Many morbid vegetations adhere to the mitral and aortic valves loosely or by pedicles, and may be broken off by the rush of blood into or out of the ventricle. Some, but smaller, fragments may, as Mr. Lee suggests, be washed out of atheromatous parts of the larger vessels.*

So long ago as 1837, it occurred to M. Legroux† to explain a case of sudden obstruction of the arteries of the lower extremities by the passage of the

* Lee, on Gangræna Senilis, *British and Foreign Medico-Chirurg. Review*, vol. xx. p. 214.

† *Bulletin de l'Acad. royale de Médecine*, tome i. p. 434.

fibrinous plugs found in them from the heart. A similar explanation was given by M. Laugier to the Anatomical Society of Paris, in 1849, respecting a yet more remarkable case. A healthy young man died with a needle in the left ventricle of his heart, and with gangrene of the left leg. The needle was found fixed in the apex of the ventricle, with its point directed towards the aortic orifice, and covered with 'decolorised sanguineous concretions, very coherent and irregular,' which were prolonged into the aorta. The lower end of the aorta, and the iliac arteries on both sides, were filled with an adherent clot. It seemed plain that the plugging of the latter, and the consequent gangrene, had their origin in the detachment of fragments of the lymph which had first adhered to the needle.* Since that time the researches of Dr. Kirkes have shown a similar occurrence to take place in the cerebral arteries. Mr. Paget has demonstrated it in the pulmonary arteries; and Virchow, Simpson, and others have made us acquainted with it in other vessels.

An accident precisely similar in its nature, but occurring in another portion of the circulating system, is now known to be occasionally fatal in acute rheumatism, as well as to bring on the most fearfully sudden deaths in some puerperal women. The plugged artery in these cases is the pulmonary, or several of its branches, and the plug is either formed in the right side of the heart, or passes through it from the systemic veins.†

The facts from which the explanation of these occlusions of arteries is chiefly drawn, have already been partly stated: 1. The artery is often healthy at the site of the obstruction. It may, indeed, be atheromatous, inasmuch as the occurrence in question prevails most in persons whose arterial system is diseased. Yet it is often healthy, as might be expected if the disease originated elsewhere. Sometimes the vessel is dilated to nearly twice its natural size, and, in the branches of the internal carotid especially, this enlargement renders the situation of the plug evident before the artery is opened. 2. The plug is frequently not adherent to the vessel. The cases under consideration were for a long time regarded as effusions of lymph from the surface of an inflamed artery; but when the artery is healthy, and the plug free, that explanation is plainly erroneous. There are, indeed, not a few instances in which the coats of the artery are inflamed, and even suppuration has taken place in the surrounding structures; in these circumstances, the plug is found adherent. The inflammation, however, and the adhesion, are alike the result of the previous presence of the plug. 3. The impacted plug can be distin-

* Cruveilhier, *Traité d'Anatomie pathologique générale*, tome ii. pp. 201, 296, 388.

† *Obstetric Memoirs*, by Sir James Y. Simpson and his editors, Drs. Prie-tley and Storer, vol. ii.

guished from the inflammatory lymph and coagulum which are formed in its immediate neighbourhood. Drs. Burrows and Rühle have given the most undeniable evidence of this fact, and have all but demonstrably traced the plug to another place of origin. Each of these observers detected a calcareous plug occluding an artery, and similar calcareous matter still attached to the wall of the heart.* 4. The cessation of the circulation in the occluded artery is too abrupt to have arisen from a gradual accumulation of fibrine. It has probably not always been discovered to be instantaneous, because the pulse has not been under examination at the moment of the occlusion. 5. The severe pain which first calls attention to the accident, and death, as it happens from such obstructions of the pulmonary artery, are both sometimes sudden. 6. After loss of sight from this cause, the twigs of the retinal artery are seen with the ophthalmoscope to be bloodless upon the distal side of the plug.

It would far exceed the limits of this article to trace the results of this accident in the various parts and organs of the body in which it has been shown to occur. As there is no trunk which may not be occluded by a detached plug, the abdominal aorta itself not escaping, so there is no organ which may not have its function impaired, or its structure destroyed, by the deprivation of blood which this accident occasions. Organs with single arterial trunks, as the testicle, retina, or spleen, may lose their function when thus deprived of their whole supply of blood.

When the principal artery of a limb is suddenly plugged in its higher part, severe pain is commonly the immediate result of the accident. In some cases this pain extends along the course of the vessel, which, though pulseless, is extremely tender; in others the suffering is referred to some distal part of the limb, as, for instance, to the calf. Signs of a deficient circulation succeed; and they may amount to pallor, loss of temperature, numbness of the surface, or even to that 'torpor' which in certain injuries of vessels is observed to precede the total death of a limb. Such torpor implies not only a loss of circulating blood in the limb, but also a cessation of feeling and motor power, and it may issue in actual mortification.

It is not every case of obstructed artery which terminates in gangrene. A collateral circulation may be established, and the life of the limb be saved. Very young subjects bear such an

* *Medical Times*, 1853, p. 135; Virchow's *Archiv*, vol. v. p. 189.

accident without any ensuing mortification. An infant will endure without loss of life the gradual obliteration of even the aorta itself at the termination of its arch. Mr. Savory has recorded an instance, probably congenital, in which 'all the main arteries of both upper extremities and of the left side of the neck were reduced to solid cords;' yet no gangrene occurred.*

The subjects of gangrene from an impacted clot have a general feebleness of the system, which may account for the progress and great mortality of it. Some persons die before any line of demarcation is formed; more sink during the process of separating the dead portion of the limb; a few survive until all its tissues are naturally severed, except the bones and some tendons. Upon the division of these, the stump may heal.

Some at least of the obscurity which invests the subject of *senile gangrene* is cleared away, if obliteration of some of the arteries be recognised among its causes. There are commonly preliminary symptoms which may have indicated arterial disease: chilliness of the foot or hand, and frequent pains for many months, forebode the attack, and the gangrene at length originates and advances by a local dusky inflammation. In these particulars the gangrene of the aged is unlike that which is suddenly produced in younger subjects by obstructed arteries, but sometimes an arterial cause of senile gangrene can be traced.

Treatment.—The occlusions of arterial trunks which are caused by external compression can rarely be relieved. For innocent tumours seldom interfere with the circulation, being rather themselves grooved by an artery than compressing it; and malignant growths, when they have reached a size and a position in which they can produce such an effect, are commonly unsuitable for an operation. No special suggestion is required for the treatment of arteries implicated with broken bones, and none can be offered for their compression in certain situations by the growth of new bone about the fragments. The chief attention will necessarily be claimed by the manifest cause of the obstruction, at the same time that all efforts must be directed to preserving the life of the limb by warmth and a suitable posture.

* *Medico-Chirurgical Transactions*, vol. xxxix. p. 214.

In the treatment of arteries suddenly occluded, it may be possible at an early stage by reasonable pressure to break up a soft recent plug in a superficial vessel, that its fragments may pass into arteries of less importance to the limb. If this be not possible or proper, care must be directed to preserve the temperature of the limb, to favour the establishment of a collateral circulation, to maintain the efficiency of the blood by suitable nourishment, to relieve pain by methods which will least interfere with the appetite, and, more than all, to guard the weakened limb from irritation, and injury, which might overtask the little vital power it still retains : these are the indications before the occurrence of gangrene. When that event has commenced, the course advised in the essay on that subject must be adopted. If the mortification advance slowly, as in senile gangrene, Sir B. C. Brodie's recommendation of a calamine cerate to the sloughing parts, and then swathing the entire limb for two or three days at a time in a very thick layer of cotton wool should be adopted ; it avoids exposure, and quiets the mind of the patient. Poultices make the parts warm for a time only, and must be frequently renewed, whilst cotton wool preserves the limb at an equable temperature, and need not be disturbed until the discharges from the part require removal.

The administration of opium is essential in these cases, on account of the severity of the pain, and some patients preserve a clean tongue and a fair appetite whilst taking it. Others, however, cannot continue to take it by the mouth, who can yet procure refreshing sleep and other benefits by the subcutaneous injection of a little morphia.

The question of diet and stimulants in cases of gangrene, especially senile gangrene, has been warmly discussed. The advocates of an animal diet assert that any treatment which deteriorates or diminishes the blood in the system, and therefore in the limb, is promptly followed by an extension of the mortification, and that the patient is strongest, and consequently the life remaining in the limb is best maintained, with such nourishment, if only its quality and amount be rightly adapted to the digestive powers of the patient, and those powers be kept in proper order. With Sir Benjamin Brodie,* they advocate the administration of stimulants in moderate quantity ; that is to say, ' any quantity of wine that does not occasion

* *Lectures in Pathology and Surgery*, p. 368

heat of skin, nor raise the pulse, nor make the mouth clammy, nor render the patient nervous or irritable, may be given with advantage; but whatever does more than this, does mischief.' On the contrary, the advocates of a very sparing farinaceous and vegetable diet assert that it checks the gangrene, whilst an animal diet and stimulants cause it to extend. The discrepancy between the two opinions, which have both been entertained by practical men, is probably to be explained by Sir B. Brodie's caution not being observed. If these patients take opium and animal food, it is essential for them to have a calomel purgative every three or four days. Without such a precaution the stomach may be disordered and the gangrene spread; but both these evils are avoided in curable cases if the precaution be observed.

The offensive odour emitted by the gangrenous parts should be overcome by dry powdered charcoal freely sprinkled amongst the cotton wool. Scales of pure iodine, contained in chip-boxes, and covered with muslin instead of a lid, are still more effective for the purpose. Being inodorous, it may be hung about the bed. Larger boxes of wood, with perforated zinc lids, and filled with sawdust and carbolic acid, may also be put into the bed. The suggestion of the iodine is from Mr. Hoffman of Margate.

Should the gangrenous limb be amputated? Surgical experience and reasoning both prompt a general reply in the negative. In many cases, the obstruction of the artery is higher than the site of the proposed operation, as, for instance, in the iliac arteries or the aorta. Amputation in such circumstances can only be done below the cause of the gangrene, and in parts which are ill-supplied with blood. Moreover, if the operation be performed on a level with or above the obstruction, as when the popliteal only is plugged, it is often unsuccessful; there still remains the constitutional exhaustion, the natural or the premature old age, or the disease of the heart, under the influence of which the patient has to rally from the shock of an amputation. And further, the instances are not few, especially amongst the younger subjects, in which, on mortification ceasing, the dead parts spontaneously slough off. Except in special circumstances, therefore, amputation should not be performed. The various events are illustrated in the following two series of selected cases; the first showing gangrene in the aged, and the second in younger subjects.

1. Gangrene attacked the arm of a middle-aged lady, who died exhausted in a few weeks, before the separation of the dead parts was complete.—A man, aged seventy-two, was attacked with inflammation at the back of the left hand, which ended in black dry gangrene. In six months death had spread, without causing pain, as far as the elbow; and in twelve months more, to the shoulder. The limb was hard, as black as smoked meat, and without cadaverous smell. In another month the arm dropped off without hæmorrhage, and the wound healed without discharge. The man was alive and pretty well four years afterwards.*—Mr. Guthrie amputated low in the thigh for gangrena senilis extending to the knee. The femoral artery was plugged at the groin. The stump did not slough: but the patient, an elderly lady, after a partial recovery, sank exhausted before it healed.†—Mr. Langstaff amputated a thigh for mortification of the leg in a man aged seventy-five. All the vessels were ossified, and could not be tied so as to stop the flow of blood. The patient, already much exhausted, died within twenty-four hours.‡—Dr. A. P. Thomson reported a case of amputation in the thigh for dry gangrene of the leg in a woman aged sixty-five. The arteries were pervious to the popliteal. The patient sank on the third day.—A man, aged seventy, died seven weeks after amputation in the thigh for gangrena senilis. It was unnecessary to tie any vessel in the operation; all were already plugged.§—Amputation in another case was survived for a time, but the soft parts took on no reparative action; they shrank and retracted from the end of the femur, and the patient died.—Mr. James of Exeter, amputated in the thigh for senile gangrene. The operation was followed by ‘constant tremor and subsultus, muttering delirium, and the sweat of relaxation;’ yet the patient, a man of sixty-eight, eventually recovered.||—Some successful cases of amputation in senile gangrene were related in a discussion at the Royal Medical and Chirurgical Society of London, in 1853. Mr. Garlike of Rickmansworth, had removed the thigh, near the trunk, four months after the commencement of gangrene at the toes, the patient in the course of his disease having likewise suffered from suppuration in the leg and in the knee-joint. Mr. Adams had seen a man, over sixty years of age, recover after a similar operation. Such cases are, however, rare, and cannot be accepted as establishing a general rule of practice. Under peculiar circumstances, as in Mr. Garlike’s case, amputation may be performed; but all that the other cases appear to show is, that the operation may possibly not be fatal in a few instances in which the strength of the patient is not much reduced, and the gangrene has existed for an unusual length of time. These, however, are just the few cases which may be capable of a spontaneous separation of the dead parts; the great majority of cases of extensive senile gangrene end in death, whether the limbs are amputated or not.

Two cases of gangrene of the lower extremity, in comparatively young subjects, proved fatal in the Middlesex Hospital; the one under the care of Dr. Stewart, the other of Dr. Goodfellow. The heart, and the whole of the arteries implicated in its disease, have in each case been preserved as one continuous preparation, which exhibits at a glance the pathology of the occurrence: vast

* Alix, Altenburg, 1778; quoted from Mason Good, *Medicine*, 1st edit. vol. ii. p. 919.

† Hunterian Museum, 141.

‡ *Med.-Chir. Trans.* vol. vi. p. 193.

§ Hunterian Museum, 2822.

|| James, *On Inflammation*, p. 552, 1832.

fragile polypi in the left cavities of the heart, and detached fragments of the cardiac mass plugging several of the arteries. In neither case had the ulcerative process deeply severed the dead and living parts.—My colleague, Dr. Seth Thompson, requested me to see a girl, of twenty years of age, whom he had admitted into the Middlesex Hospital, on account of a rheumatic disease of the heart. She had loud mitral and aortic murmurs, acute adhesive inflammation of the right posterior saphena vein, and a red, tender, and exquisitely painful swelling at the lower third of the right leg. This inflamed patch had not suppurated; but the pain in it was intense, and destroyed her rest. An incision relieved her, and after a few days a slough of fascia separated, and the wound healed with remarkably little suppuration. Inflammation was next observed in the left posterior saphenous vein. Anasarca in both legs followed, and the face became puffy. After a fortnight of great pain and much general depression, the left foot and leg became cold and dusky, and the ends of the toes shrivelled and turned black. Complete gangrene of the lower half of the leg ensued, and a line of demarcation formed. When nothing remained to divide but the bones and a part of the tendon of the gastrocnemius, I separated them, and removed the foetid limb. The stump had nearly healed when she left the hospital.—A seamstress, aged seventeen, ill-nourished, had acute spontaneous gangrene of the foot and the whole leg. There was no pulsation in the femoral artery. After amputation, the stump and the groin sloughed, and the patient died. But one small artery needed a ligature in the operation, and the iliac artery was found plugged.*—A native Christian of Salsette, aged thirty-five, was affected with spontaneous gangrene of the arm, and in eighteen days ulceration had deeply separated the dead and living parts at the elbow, and had extended along the integuments half way to the shoulder. The limb was amputated about four inches below the shoulder-joint, and the man recovered.†—A gangrenous leg was removed by amputation in the thigh from a puerperal woman, aged twenty-five. Not a drop of blood flowed at the operation, and the patient died the next day.—In another patient, aged thirty-nine, gangrene of the foot took place after parturition, the thigh was amputated three months after the delivery, and the patient recovered.‡—A man, aged thirty, suffered from an ‘epidemic malignant fever,’ which brought on a mortification of the left foot. When ulceration was going on about two inches above the ankle, the leg was amputated below the knee. No blood flowed in the operation; but the stump suppurated healthily, and the man got well.§

CHARLES H. MOORE.

* *New York Journal*, Sept. 1854, case 6.

† Hunterian Museum, 2835.

‡ Simpson's *Obstetric Memoirs*, edited by Drs. Priestley and Storer, vol. ii. pp. 46, 47, cases 23, 25.

§ *Medical Observations and Inquiries*, 1764, vol. ii. p. 152.

ANEURISM.

PATHOLOGY.

AN aneurism is defined to be a tumour containing blood, and communicating with the cavity of an artery. Thus in every aneurism there are two parts to be considered, the sac* and its contents. The sac is formed either by the vessel itself, dilated from disease, or by the condensed soft parts in the neighbourhood.

The various classifications of aneurism now in common use are based upon varieties in the anatomy of the sac. The most natural nomenclature appears to me to be that which calls an aneurism formed by the coats (one or more) of the artery a true aneurism, and one formed by the surrounding cellular tissue a false aneurism. Unfortunately the term 'true aneurism' was applied by the older authors to a tumour in which all the coats of the vessel were dilated, while they called one in which only one of the coats formed the sac 'a false aneurism;' a very inappropriate name, inasmuch as such aneurisms form the majority of those met with in practice, while the term 'false' appears to convey the idea of something exceptional and peculiar. It is undesirable to complicate the matter still further by the attempt to introduce fresh terms. I shall therefore adhere to the old nomenclature, in spite of my opinion of its incorrectness; merely observing that these anatomical refinements are of very little importance in practice; that no one troubles himself as to how many coats of the artery enter into the formation of a sac, or has any means of forming an opinion on the point before dissection. But it is very important to ascertain whether the blood is contained in a sac or no, whether that sac is or is not perfect, and whether the aneurism is of spontaneous or traumatic origin.

The term 'diffused aneurism' is also, I must confess, an inappropriate one as used to describe a tumour in which the sac is formed out of the cellular tissue; since such a tumour is as distinct and circumscribed as if the sac were formed by the

* Some authors speak of extravasations of blood among the tissues of a limb, from the giving way of an artery, as 'diffused aneurisms;' but this appears to me an error. I should term this lesion 'a ruptured artery.' The distinction, as I hope to show, is not a trivial one.

vessel itself; and accordingly in many works an aneurism is said to be diffused when the sac has given way. Such an affection, however, is equally well or better described as ‘a ruptured aneurism.’ The term ‘diffused,’ serves indeed to remind us that the blood, though now encysted, was once diffused among the neighbouring parts; but as it is liable to be confounded with the same term as used by other authors to designate extravasations from rupture, I shall prefer to use in the sequel the name ‘consecutive aneurism’ for such aneurisms as have the sac formed out of the tissues external to the vessel. In order as far as possible to avoid ambiguities, a Table is subjoined, showing the nomenclature adopted in this essay, as contrasted with that hitherto common in France and England: M. Broca’s treatise being used as an example of the former, and the chapter on Aneurism in Mr. Erichsen’s *Science and Art of Surgery* for the latter. (See the Table p. 412.)

The kinds of aneurism to be described below are as follows:

1. Common or encysted aneurism, subdivided into
 - (a) Fusiform aneurism, or aneurismal dilatation.
 - (b) True aneurism.
 - (c) False aneurism.
 - (d) Consecutive or diffused aneurism.
2. Arterio-venous aneurism, subdivided into varicose aneurism and aneurismal varix.
3. Cirroid aneurism, sometimes called arterial varix. Aneurism by anastomosis will also be considered under this head.
4. Dissecting aneurism.

COMMON OR ENCYSTED ANEURISM.

By common or encysted aneurism is meant that variety of the disease, embracing by far the greater number of cases, in which the tumour is formed of a single cyst, communicates only with a single artery, and is limited to a single point of the course of that artery. Some of the subdivisions of this affection are practically very different from each other, while between others the difference is unimportant, and in fact usually inappreciable during life.

In the *aneurismal dilatation*, or *fusiform aneurism*, the whole circumference of the artery has yielded to the force of the circulation for some considerable length of the vessel, and so a tumour has been developed, of an elongated or somewhat

TERMS USED IN THIS ESSAY.

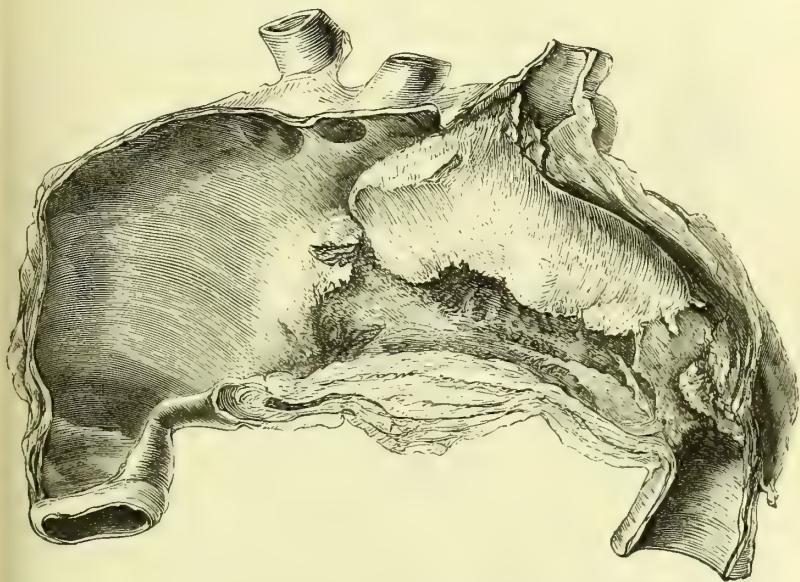
BROCA.

ERICHSEN.

I. Common or encysted aneurism. The tumour forming a single sac, communicating with a single artery at a single point. Subdivisions: (a) Aneurismal dilatation or fusiform aneurism. The sac formed by all three coats of the artery dilated over a great extent. (b) True aneurism. The sac formed by all the coats of the artery dilated at only one point. (c) False aneurism. The sac formed by only one of the coats of the artery. (d) Consecutive or diffused aneurism. All the coats of the vessel have given way, and the sac is formed out of the neighbouring parts.	Circumscribed aneurism. This is excluded from Broca's classification. True aneurism. Mixed external aneurism; subdivided into <i>sacciform</i> , <i>fusiform</i> , and <i>dissecting</i> . False, or encysted aneurism; subdivided into primitive and consecutive. Cystogenic aneurism; formed by a cyst developed in the thickness of the walls of the vessel, and afterwards communicating with its cavity. This is not recognised in either of the other classifications.	Fusiform or tubular aneurism. True sacculated aneurism. Circumscribed false sacculated aneurism. Diffused false sacculated aneurism, under which he also includes extravasations without a sac—our ruptured aneurism or ruptured artery.
II. Arterio-venous aneurism, formed by a direct or indirect communication between an artery and a vein. Subdivisions: (a) Aneurismal varix; in which the communication is direct, no tumour being formed. (b) Varicose aneurism; where the communication between the vein and artery is through the intervention of a tumour.	Arterio-venous aneurism. Aneurismal varix, or simple phlebartery. Varicose aneurism. Two forms described; the one in which the tumour is formed by a dilatation of the vein (varicose aneurism by dilatation); the other in which the sac is a new formation—encysted or false consecutive varicose aneurism.	Aneurismal varix. Varicose aneurism.
III. Cirroid aneurism; formed by the convolutions of a single dilated artery.	Arterial varix.	Arterial varix.
IV. Dissecting aneurism; an affection of the vessel occasioned by ulceration of its lining membrane, and effusion of blood between the coats.	Dissecting aneurism, considered by Broca as a variety of false aneurism. Broca describes two kinds of 'diffused' aneurism, by which he means aneurisms without a sac. This, according to us, is a contradiction in terms. Broca's first form of diffused aneurism is described in this work as 'rupture of an artery'; his second as 'rupture of an aneurism.'	Dissecting aneurism. The same remark applies to Erichsen's classification.

cylindrical shape, continuous with the cavity of the artery at each end. The coats of the vessel are generally much thinned and highly atheromatous. This form of aneurism hardly ever contains much clot. It is of more common occurrence in the aorta, but rare in the arteries of the limbs; the most usual situations below the aorta being the innominate, the top of the common

FIG. 155.



Fusiform aneurism, or aneurismal dilatation, of the aorta, half filled with laminated coagulum. (From the Museum of the Royal College of Surgeons, No. 1641.) To show the possibility of the deposit of clot in such aneurisms, and even of spontaneous cure, with preservation of the channel of the vessel.

carotid, and the inguinal portion of the external iliac and femoral (p. 398). Some authors separate the aneurismal dilatation entirely from the category of aneurisms, and treat of it as a distinct disease; but no pathological distinction can be made between this and other forms of dilated artery which would not be subject to endless exceptions and modifications, and in practice this affection is often indistinguishable from the 'true' aneurism.*

* Some amount of dilatation, associated usually with atheroma, is constantly met with in the arteries of persons advanced in life; but this hardly constitutes a tumour, and so does not deserve the name aneurismal. The arteries also become tortuous as well as dilated in elderly persons of relaxed fibre, and it

True aneurism is defined to be a circumscribed dilatation of an artery in a part only of its circumference, in which all three coats of the vessel are dilated to form the sac, while in a (so-called) *false aneurism* the two internal coats have given way

FIG. 156.



A small aneurism of the radial artery (Museum of the Royal College of Surgeons, No. 1697). to show the usual shape and relations of a common or encysted aneurism, which stands out like a bud from a portion of the circumference of the vessel.

and disappeared, and the sac is formed only by the external, or cellular, coat. The true aneurism, like the aneurismal dilatation, of which it may be regarded as a variety, is much more common in the aorta than in any other vessel; so much more so that Scarpa denied that true aneurism exists in any other artery. It is difficult, however, to refuse credence to the numerous authorities who have described the dissection of small incipient true aneurisms of other arteries in which the several coats could be actually demonstrated; but at a later period they become consolidated together at the neck of the sac, and the internal layers cannot be followed further, having been worn off by friction, if they were ever present: at this period, therefore, there is no appreciable difference between one aneurism and another as to their mode of formation. Even if the two internal coats can be followed for some little distance beyond the opening into the aneurism, this does not prove that it is a true aneurism, since the

part of the internal coats which can be traced may be merely that which would have lined the opening, and which has now been everted into the sac. The presence of a smooth, shining membrane lining the sac is no proof that the tumour is a true aneurism, since such pseudo-epithelial laminæ are very often found in new formations,* and particularly where constant

seems, from the account of a preparation by Mr. Coulson (*Path. Soc. Trans.* vol. iii. p. 302), that this condition sometimes simulates an aneurismal tumour. The patient was a woman aged eighty-eight, who for some years before her death had had a pulsating tumour, the size of an orange, just above the right clavicle, in the situation of the carotid. It had been taken to be aneurismal, but on dissection it was found that 'the vessels arising from the aorta were elongated, and considerably dilated; and the tumour consisted of a reduplication of the common carotid and of indurated cellular tissue around it.'

* See Prescott Hewett, in *Med.-Chir. Trans.* vol. xxix. p. 80.

motion has been taking place. So that it is impossible to perceive any difference between true and false aneurisms at the time at which they generally come under observation; and it is not worth while to say more on the subject, beyond stating that the true become false as they grow; and expressing an opinion, founded on the manner of their origin, that false aneurisms are far the most common.

Another form of false aneurism is described by authors of credit, and must therefore be noticed here, although its reality is doubtful. It is sometimes called 'hernial' aneurism, and the sac is formed by a projection, or hernia, of the two inner coats, or some portion of them, through a rent or an ulcerated opening in the external tunic. Whether the cases which have been put on record really prove the existence of this affection, must be left to the reader to decide for himself. It is a point rather of curiosity than of practical interest.*

The other form of encysted aneurism is the *consecutive* or *diffused*, in which all the coats of the artery (or, as frequently happens, the sac of a previous aneurism) have given way, and the blood is effused into the cellular tissue. The latter soon becomes condensed, and forms, with the muscles, ligaments, viscera, or bones in the neighbourhood, a sac for the blood, frequently distinguished from those of the previous varieties by being multilocular. The great majority of aneurisms are, if the terms be strictly construed, of the consecutive form; since few tumours of long standing will be found in which some part, at any rate, of the sac has not been borrowed from surrounding tissues.†

Such are the varieties of common aneurism, classified accord-

* There is a preparation in the Museum of the College of Surgeons intended to show this form of aneurism. Mr. Erichsen, however, reports, as the result of his examination of this specimen, that he believes the external coat not to have been originally deficient, but to have been dissected off; Cooper's *Surgical Dictionary*, 8th edition, 1861, p. 140. In this opinion I quite concur. The line at which the external coat has been cut away, is distinctly marked all round the neck of the sac. M. Broca expresses his disbelief in the reality of hernial aneurism.

† I would wish, at the risk of being accused of repetition, again to remind the reader that the term 'diffused aneurism' is very often applied to a *ruptured* aneurism, and even to a ruptured artery, *i.e.* to cases in which the blood is poured out into the cellular tissue, and infiltrates a great part of the limb without the formation of any sac. But I think that I shall be able to show reasons for saying that it is more correct, and is of considerable practical importance, to separate these cases altogether from cases of aneurism properly so called, and to limit that term to tumours provided with a sac.

ing to the anatomy of the sac. Other principles of classification have been proposed. Thus, some surgeons prefer dividing aneurisms, according to their form, into tubular, sacculated, and dissecting;* and frequently aneurisms are named, according to their cause, traumatic or spontaneous. Each method of classification is occasionally useful; but the anatomical arrangement is most generally adopted.

Causes of aneurism.—In general terms it may be said that anything may be a cause of aneurism which destroys the balance that ought to exist between the expansive force of the circulation and the reaction of the wall of the artery, so as to make the former preponderate. But none of the ordinary events which are looked upon as exciting causes of the disease can produce it without a predisposing cause in the condition of the artery itself. This condition is, in the great majority of cases, the result of *atheroma*; but on that state of the arteries enough has already been said, and the reader is referred to the previous section. Any other cause which produces a partial atrophy of the artery renders it liable to dilatation at the atrophied part: Vidal† remarks that the accidental exposure of an artery which ought to be deep-seated may induce aneurism, both by weakening the coats of the vessel, and by depriving it of the support of the soft parts. Unnatural and long-continued pressure may produce the same effect. Thus, a case is recorded in which the pressure of an exostosis produced aneurism.‡ The frequent occurrence of aneurisms in both popliteal arteries strikingly proves the origin of the affection in disease of the arterial system; the same thing is even more strongly shown by a case which is recorded of the formation of a popliteal aneurism in one ham, while the man was in bed for the treatment of an aneurism in the opposite ham. In extensive disease of the arteries, a great number of aneurisms may form, constituting what is called the ‘aneurismal diathesis.’§

* Luke, in *Lond. Med. Gaz.*, May 9, 1845; Erichsen, in Cooper's *Surgical Dictionary*, 8th edit.

† *Traité de Pathol. externe*, 1851, vol. i. p. 645. The instance which he gives is one of exposure of the femoral artery in hospital gangrene.

‡ Roux, *Quarante Années*, &c. vol. ii. p. 131.

§ Broca (*Des Anévrismes et de leur Traitement*, p. 52) instances, among other cases of multiple aneurisms, one under the care of Pelletan, in which sixty-three were found in the same body.

It often happens, however, that aneurisms are found in arteries which appear healthy in all other parts of their course ; and this seems to be more frequently the case, the farther the disease is from the heart. In these cases the nature of the predisposing cause is unknown. It has been alleged that mercury and syphilis predispose to aneurism ; but the assertion appears gratuitous. The abuse of ardent spirits is certainly an exciting cause, and may possibly produce some weakness of the vessels, so as to entitle us to consider it also as a predisposing cause. It is worthy of notice that the disease is almost unknown in early life ;* that external aneurisms (*i.e.* aneurisms of the limbs) are very rare among women, especially in the higher ranks of life ;†

* A few cases are, however, on record. Mr. Hutchinson found an aneurismal cavity connected with the aorta of a child four years of age, which he was inclined to attribute to the ulceration of a tuberculous abscess into the artery (*Path. Soc. Trans.* vol. v. p. 104). Mr. Syme has operated for aneurism at the age of nine (*Lond. and Edinb. Monthly Journ.* 1844) ; and a case of rupture of the aorta in a child aged seven and a half years, probably preceded by the formation of a small aneurism, is recorded by Dr. Armitage (*Path. Soc. Trans.* vol. ix. p. 85). Mr. T. Smith tied the external iliac artery for femoral aneurism with success, at the age of twelve. See *Brit. Med. Journ.* March 16, 1867, where a few other cases are referred to.

† Internal aneurisms seem equally, if not more common among women, when their way of life exposes them to the vascular excitement consequent on intemperance, vice, and mental emotions. Thus Dr. Rendle informs me that aneurism is a more common cause of death amongst female than male prisoners. This is shown by the annexed Table, compiled from the records of the Queen's Prison, Brixton, all the inmates of which are prisoners under long periods of sentence.

Number and Proportion of Deaths from Aneurism, of Convicts under Sentence of Penal Servitude : from January 1, 1854, until December 31, 1868.

Daily average number of Convicts during the fifteen years 1854-68.		Number of Deaths from all Causes.		Number of Deaths from Aneurism.	
Men.	Women.	Men.	Women.	Men.	Women.
6,042·7	1,059·4	1,291	214	8	5

Deaths from Aneurism, calculated on a daily average of 1,000 ; during the fifteen years 1854-68.		Percentage of Deaths from Aneurism, of the total number of Deaths during the fifteen years.	
Men.	Women.	Men.	Women.
1·3	4·7	0·61	2·33

and that such aneurisms are found most commonly upon those arteries which are most affected by the movements of the joints; while aneurisms generally are most common at those points where the flexure, or the division of a large artery, opposes some sort of check to the blood-stream. The arch of the aorta, especially at the dilated portion called the 'sinus magnus,' and at the transverse bend, is the most familiar example of aneurism occurring at the flexure of an artery; while the dilatation of the end of the common carotid, the common aneurism of the lower part of the popliteal, and the tumours which affect the cœliac axis of the abdominal aorta, usually at the root of one of its branches, will illustrate the effect of division. The aorta, popliteal, and axillary artery seem most liable to disease, as being the most constantly subject to stretching, and the two latter to forcible rupture. The constant impulse of the blood-stream against the arch must keep the root of the aorta in more active motion than any other part of the arterial system.

The influence of forcible motion on the popliteal artery is shown by an experiment of Richerand.* On a dead subject let the bones of the extended leg be forcibly driven down into the ham till the ligaments are heard to crack. The middle and internal coats of the popliteal artery will be found torn. It is true that the accidents commonly cited as causes of aneurism are not so severe as this rough proceeding; but slighter injury to the artery probably occurs, and lays the foundation for subsequent dilatation.

Again, the heart is often hypertrophied, as the consequence either of disease or of the habits of life of the patient; and where the artery is weakened by any of the above causes, it can no longer resist the increased impulse. Hence aneurism is regarded, with at any rate much probability, as a mechanical effect of the wearing out of the artery by use; the circular muscular fibres which constitute the strongest part of the wall of the vessel being, according to this theory, stretched, and partially separated. The fact that aneurism affects the systemic arteries only, *i.e.* only those vessels which convey red blood, has led some authors to believe that the formation of these tumours may depend in some unknown manner upon the quality of the blood conveyed by the artery. With our present knowledge of vital chemistry it would be absurd even to affect to give an

* *Nosog. Chir.* vol. iv. p. 73. Hodgson, *On Diseases of the Arteries and Veins*, ed. 1815, p. 64. In repeating this experiment, I have found that this is only occasionally true. I have sometimes found the artery entire; and on one occasion the external coat was somewhat lacerated, while the others remained entire.

opinion upon the possibility of this. It seems quite sufficient to state that the pulmonary system receives the force of the right ventricle only, which is seldom hypertrophied, and which, at its strongest, is perhaps incapable of generating the expansive force necessary to produce aneurism.

A case of aneurism of the pulmonary artery is on record in which the ductus arteriosus was pervious, and so red blood was admitted into the artery. But it is not impossible that the force of the left ventricle might have been reflected along the open duct.*

A more unmistakable case of pure aneurism of the pulmonary artery is the following, for which I am indebted to Dr. Rendle :—

The patient, a young woman, appeared in perfect health, when she was suddenly seized with acute pain beneath the left scapula. In two hours there was emphysema of the side; this rapidly extended over the back, chest, neck, face, arms, and even as far as one wrist. About three weeks after she brought up blood, and died immediately. The left bronchus was pierced by a small triangular opening close below the bifurcation, from which the air had escaped. The cartilaginous rings were bared and ulcerated from pressure of an aneurism of the pulmonary artery. The aneurismal sac was very small: not larger than a horse-bean.

In some persons affected with the so-called ‘aneurismal diathesis,’ the whole arterial system shows an extraordinary tendency to aneurism, without, as is said, any visible anatomical peculiarity in the vessels; but in ordinary cases of this diathesis the vessels are evidently soft and weak.

When, by any of these predisposing conditions, the wall of the vessel is sufficiently weakened, it will give way at the weakened part to the force of the circulation, and all the more surely if that force is temporarily increased by any unusual circumstance, which thus becomes an exciting cause. Hence, perhaps, the frequent occurrence of aneurism in persons of dissipated lives, and in persons who follow laborious occupations; by which not only is the heart’s action unduly increased from time to time, but also the arteries of the limbs are exposed to frequent shocks. Hence violent mental emotion sometimes gives rise to aneurism.

Two cases of aneurisms of the abdominal aorta, dating in each case from the time of the patient’s receiving sentence for a criminal offence, have come within the experience of Dr. Rendle, Surgeon to the Brixton Prison, who has favoured me with the following note: ‘A strong healthy woman, five feet eight inches high, who had never before been in prison, received a sentence of transportation for life. *Immediately* on receiving sentence, and whilst standing at the dock,

* On the connection between the quality of the blood and the deposition of atheroma, see the section on that head.

she almost fainted from terror, was suddenly seized with severe pain in the epigastric region, and fell into the arms of an attendant. The pain in the epigastric region never entirely ceased: and just six weeks after, a pulsating tumour of small size was readily to be felt. This increased in size, until it was as large as the closed fist. She lived for three or four years, being constantly kept in bed and under treatment, and then passed from under my care. Three or four months afterwards (*i.e.* five years and two months after her sentence) she was found dead in bed. No post-mortem examination was performed, but the aneurismal nature of the tumour admitted of no question. This case was so clearly traceable to the shock consequent on receiving a heavy sentence, as to leave no reasonable doubt of the immediate cause of the disease.

'The second case was also an aneurism of the abdominal aorta at the celiac axis, and came on after receiving a severe sentence, though I could not trace it so distinctly to the sentence as in the first case. When I discovered this tumour—the woman only complained of obscure pain in the part, and was at her work when I saw her—it was about the size of a small orange. I sent her at once to the infirmary, and had her put to bed. *Twelve hours* after being in bed, the aneurism ruptured, and she died in forty-eight hours. I made a post-mortem examination. Both patients were women between thirty and forty years of age, and otherwise healthy.'

Occupations which necessitate constant exercise of a limb, and frequent strains upon its joints, act both as predisposing and exciting causes of aneurism in the arteries lying near such joints. Popliteal aneurism seems to be caused in very many instances by the giving way of the circular coat of the vessel under the alternate movements of forced extension and violent flexion, to which that artery is exposed in the movements of the knee. Suppuration near an artery may lead to the formation of a consecutive aneurism, the wall of the vessel being perforated by ulceration, and the blood admitted into the sac of the abscess. This seems to be a very rare event; but suppuration around an artery may also act as a predisposing cause, by denuding the vessel, as has been already pointed out. Unmistakable instances, however, of abscesses converted into aneurisms are on record.

Mr. Liston's case is well-known,* in which he opened a cyst communicating with the internal carotid artery, believing it to be an abscess, and in which he was obliged, in consequence of the gush of blood that followed the puncture, to place a ligature on the common carotid. The patient died of secondary hæmorrhage, the result of the operation; and on post-mortem examination Mr. Liston found reason to believe that the disease was originally an abscess which had established a communication with the artery. Whatever may be thought of the real nature of the tumour in that case, there can be little doubt that

* *On a Variety of False Aneurism.* London, 1842. An interesting case of fatal hæmorrhage from communication between an abscess in the neck and the aorta is recorded by Mr. Busk, *Med.-Chir. Trans.* vol. xxix. p. 297. :

several of the other cases which are related in Mr. Liston's paper were genuine instances of communication between abscesses and arteries.* These abscesses may be the result of struma, cancer, or common inflammation. In the 34th volume of the *Medico-Chirurgical Transactions* is a very interesting case by Mr. Dixon, in which a hydatid cyst, having been laid open, sloughed, and so established a communication with the subclavian artery. The patient died of hæmorrhage. This is the ordinary result in cases of ulceration penetrating arteries. No aneurism is formed, since there is an open wound. But, in the rarer cases, such as those referred to above, the suppuration proceeds subcutaneously, and a consecutive aneurism is formed. Possibly Mr. Liston's case may have been an example of this event; but the diagnosis must be allowed to be doubtful. The following instance was one in which the artery gave way without any known cause, there being no clear history of abscess, nor any violent effort or injury to account for the laceration. A man aged twenty-nine was admitted into St. George's Hospital for a large purple swelling at the back of the pharynx, accompanied by swelling and much discoloration on the front and left side of the neck. Two days before admission, the patient while kneading some bread felt a stabbing pain near the hyoid bone. In three hours' time the throat was so swollen that he could not swallow food, and dyspnœa came on. After a short stay in the hospital, the diffused swelling of the neck became circumscribed, hard, and smaller. There was evident pulsation of the tumour, with a whirring sound, which only became perceptible as the tumour diminished in size and became harder. The patient went on well for a month, the tumour becoming reduced to the size of a walnut, when suddenly it increased in size and extended in various directions. The general beating of the tumour gradually disappeared, leaving merely a line of pulsation in the course of the carotid. Great difficulty of swallowing followed immediately; the tumour became more and more tense, and the symptoms increased. The patient died of dyspnœa six days after the sudden increase in the tumour. The parts are in the hospital museum. In the preparation, immediately below the bifurcation of the carotid artery is a small opening in the vessel surrounded by a few minute patches of atheroma. There is a large pouch formed by the cellular tissue and fibrine of the extravasated blood, which completely pushes the larynx and trachea over to the right side, and encroaches much on the cavity of the larynx. There is no distinct rupture perceptible in the sac, but it is extremely thin at one point. It is formed chiefly by blood-clot, the fibrous investment of which is very thin.

It seems probable that the impaction of a clot of fibrine in the artery may lead to its dilatation behind the obstruction, and thus to the formation of an aneurism.

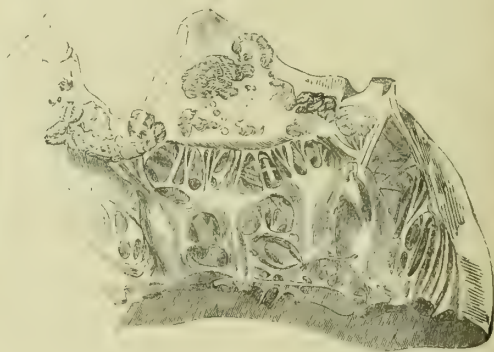
* It may not be out of place to notice here the extraordinary omission in Mr. Liston's paper of any reference to auscultation as a means of diagnosis. He admits that, before he made his puncture, he had received 'a hint that the tumour might in some way be connected with the carotid;' yet he never seems to have listened for a bruit. Had he done so, there can be little doubt that it would have revealed the existence of a communication with the artery. An interesting case of aneurism which had been sent into hospital as an abscess to be opened, and in which the diagnosis was made by auscultation, is related by M. Richet in his article on 'Aneurism' in the *Dict. de Méd. and de Chir. prat.* vol. ii. p. 309.

Mr. Tufnell has put on record* a remarkable case, in which a pulsating tumour formed in the ham, in a patient who was dying from rheumatic disease of the aortic valves. The tumour subsided with simultaneous enlargement of the collateral branches; and after death the artery was found plugged with fibrine and somewhat dilated. In this case it seems clear that the artery, being

FIG. 157.



FIG. 158.



Aneurism formed by embolism. Fig. 157 shows an aneurism of the ulnar artery; *a, b* the artery, its lower end closed by clot; *c* the sac partly filled with coagulum; Fig. 158 shows the deposit on the lining membrane of the heart.

FIG. 159.



Fig. 159. A block of fibrine deposited in the kidney in the same case.

(From a drawing in St. George's Hospital Museum. Series xxi. No. 60.)

healthy at the part where the clot became impacted, yielded to the force of the (hypertrophied) heart to such an extent as to form a tolerably large pulsating tumour, but that, as the collateral circulation enlarged, it was enabled nearly to recover its healthy dimensions. Such a case is illustrated by the accompanying figures, showing an aneurism which formed on the ulnar artery of a

* *Dublin Quarterly Journal*, May 1853.

lad, aged 17, who died under Mr. Pollock's care at St. George's Hospital in the year 1864. The deposit on the valves and the embolic clot in the kidney are also shown. The spleen was similarly affected. The artery in other parts was healthy.* If the same accident were to take place in an artery enfeebled by atheromatous degeneration, no doubt the aneurism would go on increasing.

The objection which has been urged against this mode of formation of aneurism, viz. that aneurisms do not form on arteries suddenly obstructed by ligature, is an unsound one, since they do so form, although rarely.† In most of these cases of aneurism produced by embolism the artery is previously diseased.

To these various exciting causes some have added pressure upon the artery, and consequent obstruction of the circulation, by tendinous or ligamentous bands crossing it below, or by the action of muscles; instancing the pressure of the fibrous arch from which the soleus arises as a cause of popliteal aneurism.‡

Such are the causes, predisposing and exciting, of spontaneous aneurism. The term 'traumatic aneurism' is usually intended to include only those instances in which aneurism follows a wound known to have been inflicted upon an artery; and this wound is, of course, in the great majority of cases, an open one. In such a case, the wound in the skin usually unites under pressure; the issuing current of blood prevents the lips of the orifice in the vessel from coming together, while the reaction of the neighbouring parts, the pressure of muscles and fasciæ, and the supervention of syncope from loss of blood, prevent the unlimited infiltration of blood into the cellular tissue, and the death of the patient from that cause. The blood, being thus hemmed in, quickly loses its more fluid part by absorption, and becomes a more or less solid body, and is encysted in the same way as other foreign substances. In other cases no skin-wound exists; of which the most common instance is the wound of a vessel by a fractured bone, and here the process of formation of the aneurism is the same. The form of aneurism is, therefore, the consecutive; and, *vice versâ*, most consecutive aneurisms are traumatic. Many are, however, spontaneous, being caused either by ulceration perforating an artery, as alleged in Liston's case, or (which is very common) from the rupture of a previously

* See also a case reported by the writer in the *Path. Soc. Trans.* vol. xii. p. 61.

† See *WOUNDS OF THE VESSELS*, vol. i. p. 739.

‡ Verneuil, *Bulletin de la Société anatomique*, 1835, p. 268.

existing aneurism. It has been above noticed that many, if not most, of the aneurisms which surgeons have to treat are, in one sense, traumatic, as having been probably caused by injury; the term is, however, usually restricted to those cases in which the vessel is known to have been penetrated, and will be so used in the sequel.

Progress of aneurism.—When once formed, the tumour is likely to go on increasing as long as the conditions subsist in which it originated. These conditions vary so much, according to the state of the sac, of the parts around it, and of the blood which it contains, that it is impossible to form a clear idea of the disease without studying each of these separately.

The changes in the sac depend in a great measure upon the position and size of its communication with the artery, and somewhat upon the direction in which the sac grows and the part of the artery in which the opening is seated: thus, sometimes the opening is situated on the concavity of the curve of a vessel, so that the artery is stretched over the tumour; more frequently on the convexity or bend of the artery; sometimes the arrangement of the neighbouring parts is such that the tumour can only grow in the opposite direction to the current of blood, or that pouches are formed in it. It would carry us beyond our limits to refer to instances of such arrangements, and to point out the variations in growth and progress to which they seem to have given rise. In a fusiform aneurism, in which the orifices of exit and entrance are free, the lateral pressure upon the sac cannot be severe. Hence these aneurisms advance slowly, and do not readily burst. On the other hand, pedunculated aneurisms, in which the sac communicates by a narrow channel with the arterial stream, are seldom found of large size, having usually burst before they attain anything like the size sometimes reached by the aneurismal dilatation.* The reason of this fact, no doubt, is, that the impact of the stream of blood through the narrow orifice (supposing that orifice unobstructed) is concentrated more upon one point, instead of being diffused over the whole wall of the sac, as in the previous variety. Between these two extremes there are, of course, all possible shades of difference; but in every aneurism, properly so called, as distinguished from a mere dilatation, the pressure on the wall

* Rokitansky, *Path. Anat.* Syd. Soc. vol. iv. p. 280.

of the sac is much greater than the natural pressure of the heart.

This may be illustrated by a reference to the scientific toy known as the hydrostatic paradox,* in which a small pipe communicates with a closed bellows, the pipe and bellows being filled with fluid. The smaller the opening in the bellows, the greater is the pressure on its walls. An aneurism standing out like a bud from the artery, and communicating with it by a small opening, would bear a resemblance to this machine, though not a strictly accurate one, since regurgitation would go on in the aneurism, which is not the case in the bellows.

In addition to this it may be remarked, that these small openings are sometimes, perhaps always, formed by the giving way of small portions of the atheromatous wall of the vessel. Such small atheromatous patches are sometimes met with in long tracts of healthy artery, where the wall is thin and weak, and where, therefore, a small and weak sac soon forms, and is liable soon to burst.

It does not necessarily follow, however, because the wall of an aneurism gives way, that the tumour therefore bursts. The process is usually a gradual one; and as the old wall is thinned and absorbed, inflammation proceeds in the tissues surrounding the sac, and, by condensing them, supplies the tumour with a new envelope. On minute examination of most large aneurisms, it will become evident that portions of their sac are formed by cellular membrane, muscles, and other tissues, which have originally been distinct from the tumour. In other cases, and especially when the tumour has perforated a bone, its sudden increase marks the occurrence of a large rent in its walls, and the supervention of a large consecutive aneurism upon the original disease.

Another very important element in the condition of the sac of an aneurism, is the nature of the parts by which it is surrounded; since, when the tumour meets with the resistance of bone or other dense tissue, the sac is absorbed or worn away; whilst, when it presses upon organs which are very sensitive, or whose function is important, reaction and inflammation are soon excited by the pressure of the increasing tumour; and in such cases, if the inflammation does not pass a certain limit, perhaps consolidation may ensue, otherwise ulceration will take place. A singular complication of aneurism is where the tumour pro-

* Or hydrostatic bellows. The machine will be found described in most treatises on hydrostatics; e.g. that in the *Encyc. Brit.* 8th ed. vol. xii. p. 81.

jects into the cavity of a neighbouring vessel, usually the pulmonary artery, or one of the cavities of the heart. Here ulceration seems to take place early, unless the pressure of the sac produces death. When veins lie contiguous to an aneurism, they are usually closed by the pressure of the tumour. Cases, however, are on record in which an aneurism has burst into the cavity of a vein. This circumstance will be again referred to in the section on arterio-venous aneurism.

The changes which take place in the neighbouring parts are due either to the pressure of the tumour or to the inflammation which it excites. The growth of an aneurism is often so rapid, that the effects of its pressure are very striking. Veins are closed, nerves expanded and thinned, muscles stretched and wasted, bones roughened or perforated, and even the skin itself sometimes so atrophied as to give way. When aneurism produces irritation in the surrounding parts, the latter may slough or suppurate.* The sac is also usually involved in the action, and then the aneurism is opened by the separation of the slough, or the bursting of the abscess. This is usually accompanied by fatal hæmorrhage; but it may lead to the spontaneous cure of the disease, as will be pointed out under that head. The great difference often observed in the progress of internal aneurism, according as it presses upon a mucous or a serous surface, has been well shown by Dr. Gairdner.† The hæmorrhage produced by the ulceration of an aneurism into a mucous cavity, as the pharynx, œsophagus, or intestine, usually proceeds from a minute orifice, and occurs by small quantities at a time, the opening being very liable to obstruction by a clot; while the opening on a serous surface, as the pleura or pericardium, is often, perhaps usually, a large rent, through which rapidly fatal hæmorrhage takes place.‡ Surgical aneurisms do not very often come into contact with either of these classes of mem-

* Roux, *Quarantes Années*, vol. ii. p. 260, relates a case in which he believes that an abscess formed over an aneurism, and communicated with it. This case, however, must be allowed to be somewhat dubious. Another and much clearer case of an abscess forming over and opening into an aneurism of the aorta may be found in Broca, *op. cit.* p. 166.

† *Med.-Chir. Trans.* vol. xlii.

‡ Mr. Obré relates a curious case, in which an aneurism ulcerated into the pericardium by three small openings, each of them only about large enough to contain two bristles. Death was rapid in this case; but had a similar ulceration occurred into the pleura, life might have been sustained for a considerable period, or the openings might have closed. (*Path. Soc. Trans.* vol. iii. p. 307.)

brane, but the synovial cavities bear a great analogy with the serous, in this as in other respects; accordingly, hæmorrhage from the bursting of an aneurism into a joint is generally rapid and profuse. Two cases of great interest will be found in Dr. Gairdner's treatise, in which the spontaneous opening of an aneurism through the skin was followed by healing of the orifice, and in one case possibly by a cure of the disease; and other instances are on record in which aneurisms have been accidentally opened without ill effects—nay, in some with good effect, from relief of the tension. It is more usual for an aneurism to communicate with one of the large mucous cavities of the body, than with any other part. Then the progress of symptoms usually is, that a slight hæmorrhage occurs, which both weakens and alarms the patient to some extent. The bleeding then ceases, whether from syncope, from displacement of parts creating obstruction, or from plugging of the opening by displaced clot; but this cessation is temporary: the fissure reopens and enlarges, and the patient dies exhausted after a few recurrences of bleeding. Sometimes the bleeding occurs in such a situation,* or in such quantity, as to extinguish life in a moment; but these cases are usually under the care of a physician. Surgical aneurisms, when they burst, usually open into the cellular tissue or into a joint. In the latter case bleeding is generally copious, and the cavity becomes so much distended that pulsation is felt in it. The bursting of an aneurism subcutaneously is usually accompanied by great pain, and by rapid and gradually increasing hæmorrhage, producing faintness and syncope; but the symptoms and treatment of these accidents will be more fully considered hereafter.

Another termination of a growing aneurism, which is frequently met with in those affecting the extremities, is by gangrene, the result of pressure. This takes the case out of the category of common aneurisms, and it must now be treated like any other tumour producing gangrene. Aneurisms may remain stationary for a long period, though this is extremely rare. Sometimes, after the apparent cure of an aneurism, *i.e.* after it has ceased to pulsate and become stationary, it will again commence to grow, and the pulsation will recur; and in a case

* See, in the *Path. Soc. Trans.* vol. x. p. 84, two cases in which aneurisms of the abdominal aorta burst, and the blood was effused around, and constricted, the œsophagus in one case, and the duodenum in the other.

of this kind, which has furnished a preparation to the museum of St. George's Hospital, increase of size was noticed without any return of the pulsation.*

In that case the artery had been tied above the tumour, and the increase of the latter, which was very marked, from the size of a hen's egg to that of the egg of an ostrich, and which continued during twelve months, led to the suspicion that the diagnosis had been mistaken, and the disease not aneurismal, but malignant. However, the tumour became at last stationary and solid, and the cure lasted during the rest of the patient's life, about one year. After death, the accuracy of the original diagnosis was established. In this case the cause of the absence of pulsation was obscure; but pulsation may sometimes be absent merely in consequence of the position of the opening; and in some cases no bruit may be audible, the orifice being at the deep surface of the tumour, and the force of the stream probably broken by clots. Such was the case in a woman under Mr. Vincent's care at St. Bartholomew's Hospital, in whom an aneurism followed the occurrence of a longitudinal rent in the posterior tibial artery, on its anterior face. The sac being formed at the posterior part of the artery, the stream of blood seemed to enter it indirectly. Hence probably the absence of pulsation. Nor was there any bruit. The diagnosis, therefore, was only made, after a long course of treatment, by an exploratory incision, when amputation became immediately necessary. I am indebted to Mr. Moore for the notes.

The changes in the blood contained in the sac are even more important than those in its walls. They refer to the nature and amount of clot formed in it. It is this clot which, by strengthening the wall of the aneurism, enables it to resist the action of the heart, and so opposes further increase, and which, by its constant increase in size and density (fresh clot forming as the old contracts), encroaches upon and finally obliterates the cavity. As this is the only cure of which the disease admits, except by ablation or in the very rare case of spontaneous cure by sloughing, it is to obtain the deposition of an efficient coagulum that all the efforts of surgeons and physicians in the treatment of aneurism are directed.

In examining an aneurism after death, two kinds of blood-clot will be found in it. The one, which lines the sac, and is usually very firmly united to it, is tough, more or less decolorised and laminated, much resembling layers of different-coloured leather. The laminae, and the differences of colour, obviously mark a gradual and successive deposition. This laminated coagulum is now frequently called, after Broca, 'active clot.'† The other

* Prescott Hewett, *Med.-Chir. Trans.* vol. xxix. p. 75.

† The name does not seem a very well-chosen one, since it is rather the process than the clot which deserves to be called active. Looking at such a

kind is soft, amorphous, and red, something like currant-jelly, and is always found inside the former. This soft clot (otherwise 'passive clot') may be a mere post-mortem appearance; but it is no doubt often formed in aneurismal tumours during life. I entertain no doubt that the soft amorphous clot is the first stage in the formation of the laminated fibrinous coagulum; and that it must be so in some cases is proved by the fact that aneurisms are sometimes cured by pressure in a very few hours. Now in those cases, there has been no time for the formation of laminated coagulum. The sac must in the first instance have been filled with soft clot, and it seems in the highest degree probable that the soft clot has often become gradually hard and laminated.* The formation of soft clot, however, is not a matter of the same importance as that of laminated coagulum; indeed, a too rapid deposit is perhaps in some cases to be deprecated, as leading to a delusive appearance of cure. It is liable to be either melted or washed away by the circulation, and then the tumour, which seemed to be cured, begins to grow again.

It will be remembered that the first phenomenon of atheroma consists in the deposition, out of the fluid blood, of a fibrinous stratum on the wall of the artery. The commencement of coagulation in an aneurism bears, at any rate, a strong resemblance to this; but, unlike the formation of atheroma, it seldom, if ever, takes place where the sac is exposed to the full force of the blood. The least diminution of the circulation, however, as from pouches in the sac, from roughness of its walls, or from external causes moderating the impulse of the heart, will lead to the formation of tough fibrinous coagulum on the wall of the aneurism, though what is the exact physical cause of this coagulation is unknown. It seems to require for its commencement a diminution of the circulation, but not its entire stoppage; indeed, it sometimes seems to go on less readily when the stream is stopped altogether. When once this tough fibrinous coagulum is formed, it has a tendency to propagate itself through the contiguous layers of blood until the whole sac is full, unless the stream of blood should be too strong for it; and when once formed, the clot acquires greater density, partly by the inherent

clot, which has remained for years unchanged in a cured aneurism, one would be inclined to say that nothing could well be more *passive*.

* See Richet, 'On Aneurism,' *Dict. de Méd. et de Chir. prat.* vol. ii. pp. 282-295

power of contraction possessed by fibrine, partly because it is, as it were, hammered out by the impetus of the circulation. It is interesting to compare different parts of the same sac: here, fibrine accumulates in strata; there, all is worn away—the sac, the surrounding soft parts, the periosteum, even the bone. A careful study of the parts will generally prove this to be owing to the impact of the stream of blood, and to the resistance of the surrounding parts; the attrition to which the sac is thus subjected easily explains its absorption. In this process of absorption, it seems that the clot may also be involved; that is to say, that even laminated coagulum may, in some conditions of the sac, be removed—an effect which can hardly be attributed to anything but the action of the vessels of the sac upon it. But if the vessels of the sac can remove the clot, may they not also deposit it—that is, may not the laminated fibrine which lines the clot be an exudation from its vessels, rather than a kind of precipitate out of its contents? This is the opinion of some pathologists,* who consider the process as somewhat analogous to inflammation. But if it were so, the internal layers of clot ought to be the oldest, having been pushed inwards by the increasing deposit; now every-day observation of their colour and consistence proves that they are the most recent. The exact cause, however, of the formation of laminated clot must be allowed to be obscure. It is enough for our present purpose to know that in an aneurism such clots have the greatest possible tendency to form, and will form almost inevitably to some extent when the full force of the circulation has been withdrawn. Even in tumours which are rapidly increasing, it is usual to find coagula in parts where the stream has been less powerful.

The nature of the connection between the sac and its lining of fibrine, is another obscure point in pathology. M. Broca, in an interesting passage of his valuable work,† endeavours to prove that the laminated clot formed in an aneurism possesses a certain grade of vitality, however low. But the facts which he adduces to prove the vascularisation of such coagula do not appear strictly applicable to aneurismal clots. John Hunter and Blandin have injected clots in arteries after ligature, and Kiernan in a concretion forming in a vein below a tumour; but in both these cases there are evident sources of vascular formation,

* Colles 'On Aneurismal Sacs,' *Dublin Quarterly Journal*, 1856, vol. xxi. p. 53; Wardrop, article 'Aneurism,' in Costello's *Cyclopædia of Surgery*.

† Op. cit. pp. 127 seq.

which do not exist in a cured aneurism ; nor have I succeeded in meeting with any unequivocal proof that vessels pass between the sac and its lining of coagulum, nor with any facts which prove that such clots ever share in the vital actions, inflammatory or otherwise, of the parts around them, except the partial absorption mentioned above, which very likely is an absorption merely of the watery parts of the clot ; so that the cure by laminated fibrine, when once complete, may be expected also to be permanent. There are cases where, after apparent cure, the aneurism has reappeared sooner or later, and sometimes after many months of apparent inaction. In such cases it is probable that either the clot was not complete, but allowed circulation to go on through its cavity, or that a portion of it was of the soft, not the laminated, variety.

As to the statistics of aneurism as it affects the different arteries in the body, I do not believe we are in a position to make any statements worthy of credit. In Dr. Crisp's work may be found an elaborate table of all the cases published up to that date ; and Dr. Sibson has since given still more extensive researches as to aneurism of the aorta. Such tables are of great interest and utility in some other respects, principally in reference to the usual course and termination of each class of cases. But they are useless for the purpose of showing the liability of individual arteries to disease, since they always include an unnatural proportion of 'interesting' cases. Thus in Dr. Crisp's table of 551 cases, the popliteal aneurisms (137) are nearly as numerous as those of the thoracic aorta (175) ; and adding femoral (66) to the former, the proportion of surgical aneurisms in the lower extremity would be greater than thoracic—an absurd conclusion. The only way to determine the relative frequency, with any approach to correctness, would be to take the unpublished and miscellaneous records of our large institutions, such as our hospital registers ; and even this would not be absolutely correct, since, after all, it would only give the proportion among the working-classes. The point is perhaps hardly worth the trouble necessary to decide it.

SPONTANEOUS CURE OF ANEURISM.

Since aneurism is a disease which consists essentially in disturbance of the natural equilibrium between the force of the circulation and the elastic reaction of the arterial walls at the part affected, and since the blood which fills the aneurismal sac shows a strong tendency to coagulate when the full force of the circulation is diminished, it follows that the disease is one peculiarly easy of cure in favourable cases ; for the coagula formed by the external layers of blood in contact with the wall of the sac soon acquire an organic connection with it, and thus strengthen it, and, if uniformly deposited, enable it to resist the

impulse of the blood over its whole circumference, and thus to check the further progress of the disease. When this has been once effected, *i.e.* when the whole wall of the sac has once recovered its power of resisting the distending force of the circulation, coagulation will generally advance from without inwards until the whole sac is filled with solid fibrine. The process may of course be interrupted by anything which temporarily augments the force of the circulation, such as intemperance, disease, exertion, or perhaps even great mental agitation; or it may be retarded or suspended by internal causes which modify the coagulability of the blood.

Several conditions or modes of spontaneous cure have been pointed out by pathologists. 1. The most simple, and as it seems the most common, is the coagulation of the blood in the sac in consequence of mere retardation of the circulation. 2. Another cause of coagulation in the sac, much insisted on by writers, but rarely if ever seen in nature, is the pressure of the aneurismal tumour upon the artery in the neighbourhood of the sac, whereby the entrance of blood into the aneurism is hindered. 3. Another method, which has often been proved by dissection, is the stoppage of circulation through the tumour by a piece of clot which has been washed into the mouth of the vessel as it leaves the aneurism, or even at some distance from the latter. This plugs the opening incompletely at first (at least in most cases), but increases gradually by a deposition of fresh fibrine, till the orifice is quite closed. The circulation is then diverted into the collateral arteries. 4. In some much rarer cases, a clot may be carried down into the artery above the tumour from an aneurism higher up, or the retardation caused by the latter may cause coagulation in the lower sac. 5. Another method of spontaneous cure is by suppuration and sloughing of the tumour; and it is believed that aneurisms may be cured by inflammation of the sac without suppuration.

The fact that few aneurisms are found without some formation of laminated clot upon, at any rate, a part of their circumference, shows how strong is the tendency to cure. Wherever the wall of the tumour is sufficiently strong, clot will form upon it during any temporary diminution of the force of the circulation; and this clot will encroach upon the cavity, and may form the nucleus for a complete cure. Unfortunately it usually happens, and especially in aneurisms situated near the heart, that this effort is only transient. Either the circula-

tion, recurring with greater force, overcomes altogether the barrier set up against it, and reproduces the uniform expansion of the sac, or the sac has some weak point where the clot does not form, or the circulation in the centre of the tumour is too powerful for coagulation to go on there. The form of the tumour, and the nature and size of its orifice of communication with the artery, must of necessity exercise great influence on the probability of this event. Thus a tumour formed by a mere expansion of the artery (fusiform dilatation) will have a much more powerful stream passing through it than one which stands out from the vessel like a bud, and is attached to it by a kind of neck.* Tumours of the latter form are, it is true, comparatively rare; but the intermediate form, in which the dilatation is confined to only a part, and that not a very large part, of the circumference of the artery, are the most common—at least among surgical aneurisms—and are much more prone to spontaneous cure than the fusiform aneurism. Then the state of the mouth of the sac will exercise an effect on the stream. If the orifice be smooth, and the internal coat prolonged into the sac and free from deposit, the blood finds no obstacle to its passage; but in contrary conditions, with a rough orifice and coagula projecting into the artery, the force of the blood must be much broken. Some pathologists believe, with Cruveilhier, that clot is never deposited on the smooth wall of an aneurism formed by the healthy arterial coats simply distended; hence that tubular aneurisms never contain coagula. It is very difficult to be sure of this. The figure on p. 413 shows that laminated coagula are at any rate sometimes found in sacs of this sort, and it is scarcely possible to discover what was the condition of the lining membrane at the point where the coagula were deposited.

The statement that aneurism is a mechanical lesion, and that its cure is to be sought by mechanical means chiefly, is not meant to exclude from consideration the advantage that may be derived from an increase in the relative quantity and coagulability of the fibrine of the blood. It is true that the attempts which have been made to induce coagulation directly by chemical means have as yet partially failed; but methods, such as bleeding and starvation, which increase the relative

* But though the stream is more powerful, its lateral expansion, *i.e.* the pressure on the wall of the sac, is much less so. Hence the fusiform dilatation rarely attains the size of the saccular aneurism, and is not prone to bursting.

quantity of fibrine,* and diminish the force of the circulation, have often succeeded by themselves, and, when not pushed beyond what is prudent, form an important adjunct to some other plans of treatment.

The reader may now be asked to consider briefly each of the conditions or proximate causes of spontaneous cure spoken of above. The first is the mere retardation of the circulation. This may take place under conditions which it is impossible to foresee and therefore to produce; but the chief and happily always accessible requisite is *rest*, which has been frequently known to effect the cure of aneurism, whether external or internal, with little assistance from any other means.

Such an instance is the following: A man was admitted into hospital, under the care of Mr. Luke, on account of a tubular aneurism of the femoral artery, unaccompanied by bruit or affection of the pulse in the lower part of the limb. The tumour was of a year's standing; it was compressible, and could be emptied of its contents. A plaster and bandage were applied, but apparently not so firmly as to produce much pressure, and he was put to bed. A good deal of pain was felt under the plaster for half an hour. It was left on for five days, and at the end of that time the tumour was found solid, and pulsation had ceased in it and in all the arteries of the limb. At the last recorded examination of the patient, two months afterwards, the pulse in the limb had not reappeared.†

A great number of such cases might be cited from the various authors who have treated this subject. Hence the first advice given by a medical man to a patient in whom he discovers the existence of aneurism is to keep quiet. It is a pity that this recommendation is not made more stringent. The patient, instead of being merely enjoined to lead a quiet life and avoid all causes of excitement, should be rigidly confined to bed and to the recumbent position. But a still more powerful remedy consists in spare diet, though this should never be used except as an auxiliary to rest.

The following case deserves notice as illustrating the possibility of cure even in a condition usually regarded as quite hopeless.‡ A publican consulted Mr. Stanley in October 1847, for a large pulsating tumour in the right breast, which *was rapidly increasing*. The symptoms do not concern us here; it was diagnosed to be aneurism; and he was advised to go home and keep himself perfectly quiet. Accordingly he went home, lay in bed for six months, and fed only on

* On the influence of bleeding and starvation on the amount of fibrine, see Todd and Bowman, *Phys.* vol. ii. pp. 311, 312.

† Luke, in *Lond. Med. Gaz.* May, 1845. For other cases see Bellingham, *On Aneurism*, p. 148.

‡ *Path. Soc. Trans.* vol. v. p. 107.

beef-tea, milk, and light pudding. At first the tumour seemed to grow; but from Christmas of that year its walls gradually got harder, the pulsation diminished in force, and by March 1848 were no longer perceptible externally. He then left his bed, having become by this time very pale, emaciated, and feeble. He lived very abstemiously for four years and a half, when a general election 'excited him to deviate from the tranquil and abstemious habits he practised.' He died of acute pleurisy after exposure. A large sac was found communicating with the aorta by an opening (1 in. by $1\frac{1}{2}$ in.) just below the innominate artery in the posterior wall of the vessel. There was only a cavity large enough to contain a horse-chestnut, the rest was all filled with firm coagulum. The tumour had been of enormous size ($7\frac{1}{2}$ in. from side to side and 4 in. vertically). The disease which proved fatal appears to have been quite unconnected with the aneurism.

Bleeding is also a powerful agent in this plan of treatment. It is a remedy now little used, in consequence of its abuse in the time of our fathers; but it may be permitted to us to doubt whether the reaction has not been carried somewhat too far. Doubtless the repeated and copious venesections of old times could hardly be otherwise than injurious. Valsalva, it is said, used to bleed his patients day after day till they were unable to stand, and could hardly raise their arms from the bed.* This is an excess to which our modern habits as well as the prejudices of our patients, would effectually prevent surgeons of the present day from resorting; and there can be no question of the danger and impropriety of bleeding, when so insisted upon.† But the moderate use of venesection appears both rational and, as far as we can judge from recorded cases, successful. Bleeding seems to increase the relative amount of fibrine in the blood;

* Hodgson, op. cit. p. 145. Some writers have thought that the usual representations of Valsalva's practice are exaggerated; but it is clear, from Albertini's account (*Acta Acad. Bonon.* vol. i.), that its general principle is correctly understood.

† M. Broca seems favourable to the application of the method of Valsalva in the treatment of aneurisms of the thoracic and abdominal aorta, and of the subclavian artery. I do not observe, however, that he has given any instances of the application, successful or otherwise, of this method, except one, the reference to which I have been unable to verify; nor have I met with any instance of the application of Valsalva's method, properly so called, in modern practice. In a case brought before the Pathological Society, by Dr. Broadbent (*Path. Soc. Trans.* xiii. 44), dyspnoea, the result of an aneurism of the aorta, had been much relieved by bleedings practised at rare intervals; but this is of course quite a different thing from Valsalva's treatment. Porter speaks of having bled to syncope, several times, a patient with aortic aneurism, and always with marked relief: op. cit. p. 82. In Mr. Hodgson's work numerous cases will be found quoted, where a practice more or less closely resembling that which goes by the name of Valsalva was followed with success.

nor does it appear, when moderately used, to lessen its coagulability; while its effect on the power of the heart and the rate of the circulation may be calculated with some approach to certainty. That this effect is transient is very true, but so is the action of all the cures for aneurism. A transient effect on the circulation is all that is needed for the formation of laminated clot, which will then, in favourable circumstances, go on to extend itself. Besides, bleeding has the recommendation that it can be repeated, and its quantity proportioned exactly to the condition of the circulation. The great objection to its use appears to be, that (in internal aneurisms especially, but in all aneurisms to some extent) the antagonism between the heart's action and the forces acting in the tumour has a tendency to cause stoppage of the heart, and death from syncope.* This is especially likely to happen in the fluttering action which succeeds copious venesection, and it is on this account mainly that bleeding is dangerous. Still, there are too many records by different, and those the most competent, observers, to allow of doubt as to its great utility, in some cases, although probably in this, as in so many other things, the acute judgment of Sir T. Watson has hit the mark when he says that venesection is only admissible so far as to reduce *excessive* arterial action. For this purpose it is certainly a more manageable and more certain agent than digitalis. Dr. Stokes has suggested a modification of Valsalva's treatment, in which the small and repeated bleedings which Valsalva prescribed are retained; but the diet is opposite to Valsalva's. 'It should,' says Mr. Porter, to whom we owe our knowledge of this suggestion, 'be light and very nutritive, but of course free from any material of a stimulating nature.' (Op. cit. p. 81.) It does not appear that any marked success has attended this plan.

The medical means available for the cure of aneurism, beyond those just enumerated, are very few. Certain drugs which retard the circulation have been used for this purpose; but without much success. Digitalis is both dangerous and uncertain. The action of tartar emetic, or of copious watery purges, seems only to be to produce weakness, which can be done with less distress by the means above enumerated. Some of the alkaloids exert a remarkable influence on the heart's

* 'An apprehension has been entertained by some, that a patient suddenly reduced to a state of syncope might never rally, and actually die of, or be killed by, the operation; and perhaps such a casualty may have occurred.'—Porter, *On Aneurism*, p. 83.

action; such are aconite and veratrum.* Whether these have ever been used in internal aneurism I am not aware, but it would seem worth while to give them a cautious trial. M. Bouillaud has published a clinical lecture† *On the Treatment of Aneurism by Iodide of Potassium*. Four cases are related, all of which were benefited and one was thought to be cured. I have not myself perceived any benefit from the use of this remedy, though I have occasionally prescribed it for long periods of time, gradually increasing the quantity to enormous doses. The acetate of lead has been recommended by Dr. O. Rees‡ on the authority of a case of popliteal aneurism in which no other treatment was employed, and the tumour gradually consolidated as the patient was brought under the constitutional influence of the drug. My own experience of this plan also is, I regret to say, negative; but I regard it as the most hopeful of the medical means available for the treatment of aneurism.

It is possible that an aneurism, though beyond operative interference, may still be accessible to local applications (*e.g.* at the root of the neck, or in the chest); in such a case, ice may be applied to the tumour. Some surgeons use refrigeration, as an accessory to pressure, in the case of external aneurism. The method is one of doubtful efficacy. I have seen it tried occasionally, but without any effect. It should not be forgotten, that gangrene of the skin has been so produced.§

It seems to follow from the above facts that when aneurism is beyond operative interference, the best thing that can be done is to keep the patient quiet in bed for months, and years if need be, avoiding all causes of excitement, mental and bodily; to administer a light, unstimulating diet, but without denying him sufficient nutriment; to keep the part in such a position as may rather impede the supply and favour the return of blood; to use venesection in small quantities, and carefully, when the circulation appears at all above the normal standard, which, it should be remembered, ought to be below that of health; and, finally, to surround him with an equable cool

* On the action of veratrum, see *Lancet*, vol. i. 1862, p. 21.

† See *Brit. and For. Med.-Chir. Rev.* Jan. 1860. Another successful case is referred to in the *Am. Journ. of the Med. Soc.* Oct. 1865, under the care of Dr. Sewall of Canada. Here, however, starvation and absolute rest in bed were also employed.

‡ *Lancet*, 1865, vol. i. p. 280. Another successful case is related by Dr. Daly in the *Lond. Hosp. Reports*, iii. 179, where, however, absolute rest and local cold were also used.

temperature. A cautious trial may be made of the acetate of lead, of the iodide of potassium, or of any of the drugs which act more immediately on the circulation; but I do not think that there is sufficient prospect of benefit from their employment to render it justifiable to insist upon their use to the prejudice of the general health. Some very gratifying cures have been wrought by such-like medical means; and although, perhaps, the cases will not be many, yet some lives will be spared by the judicious use of such means, which would be sacrificed were the opinion acted upon that the disease is a necessarily fatal one, for which art can do nothing.

The second method of spontaneous cure, above indicated (p. 432), is that in which the artery is presumed to be obliterated above the sac by the direct compression which is exercised upon it by the aneurism. It is thought that a tumour, arising by a narrow neck from the artery, may fall back, as it were, upon the latter and close the vessel. This conclusion is drawn from dissection of cases principally of popliteal aneurisms, which have advanced to a large size, and have then become obliterated by clot. It may be remarked that, from the very nature of the case, such dissections must always be subject to much doubt; inasmuch as, at the period of the dissection, coagulation has advanced to such an extent that it is hardly possible to tell where it began; and that appearances nearly, if not quite, identical are found in tumours where it is clear that no such pressure could have been exercised; and further, that the explanation arose from those false views of the pathology of arteries which led surgeons, some years ago, to regard inflammation of their internal coat as a common result of pressure,* and obliteration of the artery thereby, as a common, if not a necessary condition of the cure of an aneurism by pressure.† So it was thought that the pressure of a large tumour would so irritate the artery as to make it inflame and become filled with clot, and that thus the aneurism would be cured. We know at the present day, after so many limbs have

* See Freer, *On Aneurism*, p. 112; Hodgson, *op. cit.* p. 106.

† Most of the recorded cases are clearly instances of obliteration of arteries by impacted clot; as in the case quoted by Hodgson (*op. cit.* p. 110) from Astley Cooper, where the carotid artery was found obliterated in a case of aneurism of the aorta. This could hardly have been the result of pressure, since the effects of such pressure must have been more marked upon the trachea pneumogastric nerve, or jugular vein than the artery, but is no more than what often occurs from impaction.

been dissected in which pressure has been used, whether successfully or not, that an artery will bear, without the least visible alteration of its lining membrane or of its calibre, an amount of pressure many times greater than could be exercised by any tumour (see Fig. 161). We know also the ease with which arteries elude the gradually-increasing pressure of tumours; nor are dissections wanting in which arteries placed in the conditions supposed are found to be completely pervious.

Such a preparation exists in St. George's Hospital Museum. It exhibits an enormous popliteal aneurism, which seems to have undergone a process of spontaneous cure. Its size, however, was so great, that the pressure produced on the veins occasioned gangrene. The man was admitted on this account: the large solid tumour in the ham was thought to be malignant, and the limb was amputated.* The case occurred many years ago. No further history is preserved. The artery, which has been raised by the tumour and stretched over it for several inches, is nevertheless quite pervious. It communicates with the aneurism by only a very small mouth: and though the limb has been injected, hardly any of the injection has passed into the sac, so firmly is the mouth of the tumour sealed by clot. In this case, if ever, it might be expected that the artery would be obliterated: since the tumour, being of immense size, must have exercised great pressure, and the blood showed a strong disposition to coagulate.

It may be, however, that this method of cure is only possible when the artery is caught between the tumour and the bone, as might happen when popliteal aneurism is developed on the posterior face of the artery; but it is hardly conceivable that the tumour should ever exercise very vigorous pressure towards the bone in such a case, since it meets with so much less resistance in the other direction. For these reasons, the existence of this method of cure seems doubtful. It is, at any rate, a matter of little practical importance (though no doubt of much pathological interest), since no one would dream of encouraging the growth of a popliteal, or other accessible aneurism on the speculation of its ultimately curing itself by pressure on its own artery.

A more clearly proved mode of cure is that which is produced by the impaction, in the distal portion of the vessel, of a portion of clot from the aneurism. The occurrence of this circumstance in the arterial system in cases of fibrinous concretions on the valves of the heart, as pointed out by Dr. Kirkes, has now been universally admitted, and is a frequent cause of gangrene, of softening of the brain, &c. (see p. 403.) It seems also to be a not infrequent cause of the obliteration of arteries below an

* A similar preparation has recently been placed in the Museum of the Royal College of Surgeons.

aneurismal tumour, followed in some cases by gangrene of the limb (or by death if situated near the heart), in others by the spontaneous cure of the aneurism. The way in which this latter result is produced appears to be as follows: If a branch comes off from the artery between the aneurism and the part at which the clot is impacted, this branch may enlarge until it replaces the original artery, and the whole process may remain without result. But if no such branch comes off (as is the case in the great majority of instances, since the impaction usually occurs just as the artery leaves the aneurism), then the whole force of the heart, as far as it acts on the artery affected, is employed in dilating the sac, the artery above it, and the branches of the latter. Sometimes the sac yields to the force, and the aneurism bursts, especially under undue muscular exertion.* If this does not take place, and the circulation through the limb is still to go on, the branch or branches above the aneurism, and their communications or anastomoses with the artery below it, must enlarge. When this is effected to a sufficient extent, the full force of the circulation is withdrawn from the aneurism, which will then usually undergo the process of coagulation. It is quite obvious that it matters nothing to this process how far below the aneurism the clot may be impacted, provided that no considerable branch comes off in the interval, since the intermediate portion of artery exercises no influence on the circulation, and may, for the purpose of this argument, be regarded as part of the aneurismal sac. This process of spontaneous cure is imitated in the methods which bear the names of Brasdor and Fergusson.

This plugging process may go on gradually as well as suddenly, as is proved by its being found occasionally complete in persons who have never presented the serious symptoms known to accompany the impaction of a clot in a large artery; and still more clearly, by its being sometimes met with in an imperfect condition, the artery being lined with a tube of fibrine, which still leaves a small channel for the blood.† It seems possible that the existence of another aneurism higher up may sometimes effect the spontaneous cure of the lower one, either in consequence of clot being washed down from the upper aneurism

* Such seems to be the true explanation of a case reported by Mr. Avery, in *Path. Soc. Trans.* vol. iii. p. 88, as an instance of pressure by the aneurism on the artery above it.

† See above, *Atheroma*, p. 397.

into the lower, or into the artery as it enters or leaves the lower sac, or (as it is said) by the retardation of the current caused by the upper aneurism. It is difficult to be certain as to whether the latter mode of cure ever really occurs, though cases are on record which appear to prove its occasional occurrence. It is, at any rate, possible, since feebleness of pulse in the limb below is a constant symptom of aneurism. In the other case, *i.e.* when a piece of clot is washed out of an aneurism above, the process exactly resembles that which has just been described.

There remains another process by which aneurisms have been known to become cured; and this consists in the suppuration of the sac and the ejection of the whole tumour by a process of sloughing. In this process, as in other instances of sloughing, the artery, for some distance on either side of the gangrenous part, is closed by coagulum,* so that hæmorrhage does not take place, as might have been apprehended.† Or, in other cases, the sac may slough, and the artery, not being thus sealed, may give way, and the patient survive the hæmorrhage thus occasioned; syncope is produced, and coagulation occurs during this syncope, sealing the mouth of the artery. This, at least, is Dr. Crisp's opinion, but it is doubted by Broca; nor do I find references in Dr. Crisp's work to the cases upon which such an opinion is founded. Inflammation without suppuration, in the neighbourhood of the sac, is also spoken of by Broca and others‡ as an occasional cause of spontaneous cure. I have not been able to find any cases which are, to my mind, quite satisfactory. Some, as the case reported by Mr. Sidey,§ appear to have been cures by impaction of clot.

The surgical treatment of aneurism, as far as it is successful and rational, is merely an artificial imitation of these processes. The treatment by gradual and partial compression of the artery above the tumour, has no other aim than to imitate nature in the first of the processes described above, so as to slacken the circulation through the aneurism, and allow the blood in it an opportunity of coagulation. The Hunterian operation has essentially the same object, although it accomplishes it in a somewhat different way, and by obliterating a portion of the artery above the tumour puts a more decided, but at the same

* See MORTIFICATION, vol. i. p. 155.

† See the cases related by Hodgson, *op. cit.* pp. 103-5.

‡ Richet, *Dict. de Méd. et de Chir. prat.* ii. 291.

§ *Edin. Med. Journ.* vol. iv. p. 768.

time more temporary, check on the current of blood. The treatment by sudden or total compression, also aims at suspending the circulation through the sac completely for a short period. The cure by flexion (Mr. Hart's method) aims at combining this first process with the second, in which the aneurism is compressed by the parts around it, and itself (perhaps) compresses the vessel. Sir W. Fergusson's plan of manipulation, or crushing, is derived from observation of cases in which the natural cure was effected, or attempted, by the impaction of a clot in the artery leaving the sac. Brasdor's method, so far as it is justifiable at all in practice, *i.e.* with the modifications hereafter to be described, is identical with this in its object, and rests upon the same pathological basis. Direct pressure appears to cure aneurism usually by displacing portions of the clot, and may perhaps sometimes act by setting up inflammation in the sac or parts around it, which leads to coagulation. Finally, the old method, by opening the sac and tying both ends of the artery, bears the strongest analogy to the cure by suppuration, and is, in fact, a kind of excision of the tumour.

The methods of spontaneous cure have been dwelt upon at this length with the view of impressing upon the mind of the reader that all successful plans of treatment are successful from being imitations (whether designed or fortuitous) of these natural processes, in the hope that this fact may lead practitioners to a more careful study of the workings of nature in this particular, and the conditions under which she works. Such a study, carried on by various observers, could hardly fail to be fruitful in results which would lead to the preservation of numerous lives that would be sacrificed to the idea that internal aneurism is a disease almost necessarily fatal. What else was it than the careful study of the natural process of cure that led Hunter to his brilliant and daring proposal of tying the artery away from the seat of the disease? What else led the Irish surgeons to see that compression, in order to imitate nature, need not suspend the circulation entirely, need not even act continuously; and thus to substitute for the intolerable torture inflicted by the old plan of compression a treatment which in ordinary cases is harmless, and in a few absolutely painless? Let us remember how comparatively short a period it is since one of the most celebrated surgeons of his time* announced his preference for amputation

* Pott, *Chirurg. Works*, vol. iii. p. 220.

over all other methods of treating popliteal aneurism. Let us not forget that one of our most justly valued authors on this subject * was so satisfied with the advance which had been made at the time he was then writing, as to express his opinion that 'the improvements that had been effected in the mode of applying the ligature to arteries have brought the surgical treatment of aneurism to a degree of perfection which leaves but little room for advancement.' Nor was such an appreciation of modern surgery at all exaggerated or unreasonable to those who looked at it, as Mr. Hodgson did, by comparison with the mortality after the old operation. In our time surgery has made such rapid advances, that the mortality, which under the system praised by Mr. Hodgson must have amounted to a large percentage of those operated on,† is now very much reduced by the invention of instrumental compression, and even this will no doubt soon be further reduced by the more frequent use of flexion and digital pressure. So it may be in medical practice. At the present day, it is hardly too much to say that a patient with internal aneurism is condemned to death as certainly as one with external aneurism used to be to amputation. A century hence, we may hope, our descendants will have as solid reason to boast of their improvement upon the science of Watson and Latham as we have to congratulate ourselves on our advance upon the doctrines of Pott.

The extent to which the deposit of clot in spontaneously cured aneurisms proceeds, is one of the most curious and beautiful instances of that power of adaptation which the many processes of disease in the body furnish in such abundance to our notice. Generally speaking, the fact of the completion of this deposit implies the entire obliteration of the aneurism and of the artery for some distance on either side of it; and so great are the resources

* Hodgson, *op. cit.* p. 190.

† I am aware that in Dr. Crisp's tables the mortality of 110 cases of popliteal aneurism operated on by Hunter's method is given at twelve only, and in seven of the others amputation was necessary, and succeeded. But there is much danger in drawing conclusions from lists formed of published cases, which usually (perhaps it may be said always) include far too large a proportion of successful operations. From the comparatively few cases I have myself witnessed, I should suppose that the mortality is nearly double that which Dr. Crisp's table gives. But such questions can never be settled till our large hospitals can be persuaded to make efficient arrangements for the preservation of complete and unbiassed statistics. A very different computation of the mortality will be found further on.

of the collateral circulation, that any part of the arterial tube beyond the first three great branches of the aorta may be, and has been, obliterated without compromising the life of the patient. Thus, numerous cases of obliteration of the thoracic aorta below this point have been recorded; the innominate artery has often been successfully obliterated by nature, though only once as yet by art, and a case is even on record* in which the cœliac artery and all its branches, with the commencement of the superior mesenteric, were involved in the obliteration of an aneurism seated on the abdominal aorta, without any loss of vitality of the viscera, which must (although the fact is not stated) have been nourished from the phrenic arteries on the one hand, and the inferior mesenteric on the other.

But these great channels of vital supply, though in favourable cases they may be stopped in this gradual manner without loss of life, cannot be so without extreme danger. In rare instances, however, we see that the cure of the aneurism proceeds to such an extent as to insure the sac against the force of the circulation, but that a channel is still left by which the blood passes, as it used to do through the healthy artery.

Of this a striking instance is figured in Mr. Hodgson's work†—a tubular aneurism of the femoral artery which has been coated throughout with a thick layer of laminated fibrine, while a channel is left in the centre, through which the circulation has been carried on, just as if through the natural artery.

Another case of this species of cure was exhibited by the present writer to the Pathological Society, and may be found described in their *Transactions*, vol. ix. p. 172. The preparation in St. George's Hospital Museum displays an aneurism of the cœliac axis, of which no complaint was made and no symptoms existed while the patient was under observation during life. It has been so far filled with laminated coagulum that the walls of the sac are everywhere of great thickness, and there is only a small portion in the centre in which the clot was loose and soft, filling it only partially, and no doubt formed after death. The three branches of the cœliac axis spring from the distal extremity of the aneurism, and are in all respects natural. There could be no doubt that circulation had gone on through the central part of the sac, which had thus replaced the original artery.‡

* Hodgson, op. cit. p. 125.

† Plates to Hodgson, op. cit. pl. vii. fig. 4.

‡ See also Sir Astley Cooper's case related by Hodgson, op. cit. p. 134, and preparations from two cases in the Hunterian Museum, No. 1641, which is figured on p. 413, and Nos. 1687, 1688. The latter two preparations are a pair; they show aneurisms of the internal carotid on either side nearly filled with laminated clot. The history of the case extends over five years, and is reported by Sir G. Blane. The symptoms were all cerebral: dimness of vision, diplopia, loss of appetite, maniacal excitement, &c. Benefit was always derived from bleeding, antimony, and abstinence.

Symptoms of spontaneous cure.—The symptoms of the occurrence of spontaneous cure in an aneurism appear to vary according as the cure is produced by the gradual deposition of laminated fibrine in the sac or artery, or is the consequence of sudden occlusion of the artery by clot. When it occurs by sloughing of the sac, the progress of the disease is of course entirely different. Usually nothing is remarked, except that the pulsation becomes less violent, the tumour less prominent, and the sac, when emptied by pressure on the vessel above, more solid and resisting. Soon afterwards, in a time varying according to their size and position, the anastomosing branches will be felt enlarging, in most cases of superficial aneurism. When this is the case, the cure is generally not far off. The aneurism will soon be found transformed into a solid tumour of much less than its original bulk.

Sometimes things go on differently; the cure being ushered in by symptoms of great severity, principally disturbance of the functions of parts supplied by the affected vessel, accompanied by more or less pain, sometimes very severe.

Thus in a case of spontaneous cure of aneurism of the innominate artery, reported by Dr. J. W. Ogle,* the cure was ushered in by urgent head-symptoms, and complete unconsciousness. The carotid artery was found after death to have been obliterated; and, no doubt, the head-symptoms coincided with and were caused by the impaction of a clot in the vessel supplying the brain. In a case of aneurism of the right carotid, involving, perhaps, also the root of the innominate, treated by Wardrop's method, and reported in his work *On Aneurism*, p. 98, may be seen the account of a similar seizure. 'The patient was taken suddenly worse, and appeared to be dying; his countenance ghastly, and covered with perspiration; tracheal rattle, and inability to swallow.' Other severe symptoms were also present. He remained in this state for several hours, and then rallied. At the same time, it was noticed that the arteries of the right arm and forearm, which up to that time had pulsated more strongly than those of the left, had become pulseless. The only probable explanation of this train of symptoms is, that a portion of the clot in the sac had fallen into the subclavian artery, and closed it. The arm was partly paralysed for some time; but ultimately the anastomosing vessels enlarged, and the patient was in all respects cured.

This process of cure by impaction seems generally to occupy a period of at least several hours; but it may be completed very rapidly.

A man was under the care of Mr. De Morgan at the Middlesex Hospital for popliteal aneurism, which was treated by compression of the femoral artery. This gave him so much pain that he was with difficulty induced to keep the

instrument on, and Mr. De Morgan, at his urgent request, was about to tie the artery. The house-surgeon was sent for in the afternoon, as the man was complaining of so much pain that he insisted on taking off the instrument. The tumour was then seen to be beating violently. The pressure was removed. *Twenty minutes* afterwards, when he was again seen, all pulsation had ceased, and it did not recur. The tumour, which had been very tense and painful before, became softer; and in twenty-four hours the circumference of the knee diminished one inch. The pain and extreme tenderness subsided at once upon the arrest of the pulsation.*

The process of spontaneous cure is very often interrupted. A portion of the sac becomes strengthened by the deposition of clot; but where the circulation is more active, the sac goes on expanding, and either bursts, or causes death by pressure on neighbouring parts. Often, too, the clot, once formed, is broken down by the force of the stream; or it has been known to be dissected off from the wall of the aneurism, and has been found inverted by the force of the current, so that the convex portion of the clot, which had been moulded to the wall of the tumour, was found turned towards its centre.

Of this, the following case is a remarkable instance. In the *Path. Trans.* vol. iii. p. 46, 1850-51, is an account by Dr. H. Roe of a case of aneurism of the anterior cerebral artery, which proved fatal, apparently from increase of size and gradually advancing pressure on the brain. The tumour was of the size of a hen's egg, and consisted of two parts; the upper (farthest from the vessel) being almost translucent, and filled with soft yellowish fibrine, imperfectly laminated; while the lower compartment, which directly communicated with the artery, was filled with coagulated red blood, like that in the vessel, and separated from the cavity on the upper surface by a dense laminated mass of fibrine. This mass had attained a considerable degree of organisation, containing, with blood-discs, very numerous fibres. The convexities of the laminae were towards the artery and its special compartment of the cavity, or *vice versa* their *concavities* corresponded with the upper part of the tumour. Dr. Brinton, in a report on this specimen, believes that this peculiar arrangement of the clot resulted from the dissection off the wall of the aneurism of the ordinary laminated clot by blood from the artery, and the subsequent inversion of that clot; in fact, an interruption of the process of spontaneous cure.

In cases where the history can be followed, it usually is found that such interruptions correspond to, and are occasioned by

* In another case under Mr. De Morgan's care at about the same time, in which the tumour was rapidly enlarging, although pressure was used to as great an extent as it could be borne, he had intended to tie the artery. On the morning of the proposed operation, however, the pulsation stopped, suddenly, according to the patient's account, and it remained absent for about ten hours, and then returned, but not with the same violence. The case ultimately did well under pressure.

some unusual exertion or emotion of mind by which the circulation is unduly excited, or some accident in which, perhaps along with a similar affection of the circulation, the tumour may have been directly injured. Reference has been made above (p. 428) to a case in which the clot continued for a long time to grow without pulsation. In Mr. Prescott Hewett's account of that case, the reader will be struck by the fact, that the cure was not previously a sound one; that the pulsation recurred twice at long periods after the operation; and that, therefore, the clot was probably formed under the influence of a too powerful stream of blood, and so might be looser and less resisting than laminated fibrine usually is. Besides, the fact that the patient was far advanced in phthisis might have modified the coagulability of the blood. Many other cases are on record, in which clots, both after spontaneous and artificial cures, have softened and appeared to become absorbed; but cases in which they grow without pulsation are rare.

In a case reported by Freer, *Obs. on Aneurism*, p. 106, and quoted by Broca, a very large aneurism had been rapidly obliterated by pressure, but had never much diminished in volume. *Twenty-two years* afterwards, the tumour having grown during the interval to an enormous size, but without pulsation, it burst, and a mass of brown grumous material was discharged. The patient died, worn out by fever and suppuration. It may be noticed, that in these cases where the clot afterwards softens, it is usually remarked at the time that the aneurism does not diminish much in size after its apparent cure. This then is to be regarded always as a suspicious circumstance.

I have seen two distinct examples of this increase in size without pulsation—in one the artery had been entirely divided, and the sac afterwards gave way. Amputation became necessary from the bursting of the tumour through the skin. In the other the aneurism was nearly cured, but its size and the consequent obstruction to the circulation caused gangrene, and hence amputation was performed.

After the cure of aneurism is completed, *i.e.* after the whole cavity is filled with laminated clot, no further change takes place in the swelling except a decrease in size, very perceptible at first, while the fibrine is in the process of contracting, and which proceeds slowly for a considerable time, until the clot has assumed its condition of greatest density, in which condition it may remain during the rest of the patient's life. By this gradual contraction of the clot, small aneurisms are reduced to a size imperceptible to external examination, and sometimes can hardly be recognised even by dissection. The collections which used to be described as 'steatomatous or atheromatous tumours of arteries' were probably small cured aneurisms.

But in swellings of larger size the laminæ of the clot remain distinct, though usually decolorised, during an indefinite period. Other changes, however, sometimes take place in aneurisms which appeared to be permanently cured. These, probably, depend on the imperfect or loose formation of the clot; though later on, the wall of the tumour takes part in the action. Thus the clot may be found softened and changed into a grumous material (as in Freer's case), or suppuration may take place, perhaps, from the irritation of this decomposing fibrine, and the whole mass be ejected. This took place a year after the apparent cure of the disease in a case operated upon by Sir W. Lawrence.* Finally, the clot has been found more or less mixed with cretaceous matter.

SYMPTOMS AND DIAGNOSIS OF ANEURISM.

The symptoms of aneurism may be easily inferred from its definition. A tumour containing blood and communicating with an artery will, in all ordinary circumstances, receive pulsation from the artery; it will be situated on the course of the vessel, and will be incapable of being removed from it; it will (so long as part of its contents are fluid) diminish in size when the circulation through the vessel is stopped by pressure on the artery above, while on the contrary, some increase in size may be sometimes observed when pressure is made below the tumour; and, after the circulation has been stopped and the tumour emptied as far as possible, it may be seen to fill again gradually, and in a certain definite number of beats of the pulse, when the pressure is withdrawn. Besides these symptoms, which may be observed in every case of external or surgical aneurism, the two following must be borne in mind, which, though not always to be found, are so constantly present as to make them of great value in diagnosis. First, that the pressure of the tumour, and the diverticulum which it forms for the arterial current, will usually cause a diminution in the force of the pulse on the affected as compared with the unaffected side; and secondly, that the pulsation is usually accompanied by a peculiar rough blowing sound, called the aneurismal bruit. The assemblage of these symptoms furnishes as decisive evidence of the nature of the disease as it is possible to have of anything not actually

* *Med.-Chir. Trans.* vol. vi. p. 204.

under our eyes; and as it is rare for those which are most characteristic to be absent in external aneurism, the diagnosis does not generally present any great difficulty. In internal aneurism, *i.e.* aneurism seated in the chest or abdomen, it is very different; the tumour is often imperceptible, or if perceptible by percussion, or even by palpitation, yet the course of the vessels is so far from the surface, and the tumour may extend so widely, that it is impossible to be sure that the tumour corresponds exactly to the position of an artery. The pulsation is frequently imperceptible, or may be derived from the near proximity of the heart or great vessels, without any real connection with them—a frequent cause of error in the diagnosis of tumours, especially in the abdomen. It is impossible to stop the circulation above, and watch the tumour refilling; the inequality of the pulse on the two sides, though very useful as a corroborative symptom, may be produced by a great variety of other causes, and the aneurismal bruit is very frequently absent. Hence, while the surgeon can usually pronounce a perfectly clear and unhesitating opinion as to the existence of aneurism in the limbs, the physician is beset with so many difficulties, that although they in general pay more attention to diagnosis, and therefore may be presumed to excel more in that branch of our art, the ingenuity of physicians has not succeeded as yet in pointing out any unmistakable signs of internal aneurism; and in many cases, even where the strongest reason exists for suspecting its presence, it is impossible to come to a certain conclusion during the lifetime of the patient.

It is worth while to study the above-mentioned general symptoms of aneurism a little more in detail, particularly with reference to their bearing upon diagnosis. The diseases with which aneurism may be confounded are, tumours, or abscesses, lying upon the course of large arteries, and malignant tumours of bone, which sometimes pulsate from the development of large blood-cells in them; further, it is necessary to distinguish between aneurism and a mere enlarged and relaxed condition of the artery, in which pulsation is much more perceptible than usual. In the first place, then, an aneurism is a tumour contained in a cyst, or sac; it is therefore separable from other parts, which latter, if no inflammation has taken place, can usually be felt to glide upon it, and is more or less movable according to the depth of its connections and to the extent of its base. Next as to the nature of its contents,

These are, perhaps, more commonly a mixture of clot and fluid than merely fluid blood, and it is rare, therefore, to find pulsation equally perceptible in every part of the tumour. The character of the pulsation, it must be remembered, depends on two things; on the nature of the contents, and on the condition of the orifice. The usual character of the pulsation of an aneurism is that of a wave, gradually swelling up and gradually subsiding. There is also a lateral expansion of the tumour, so that if the two hands be pressed on its opposite sides, they will be seen to separate as the aneurism expands. There is usually superadded to this general heaving, when the artery lies between the sac and the hand of the observer, a distinct line of more rapid and thrilling pulsation, which marks the course of the vessel. This may generally be observed very plainly in popliteal aneurisms which are growing towards the knee-joint, and have the artery crossing them. The heaving character of the pulsation in aneurism differs from the more rapid and simultaneous pulsation of all its parts in a vascular tumour, which pulsates from the presence of a number of large vessels, and in which, therefore, the movement commences at all parts of the tumour, instead of being propagated from one. It differs equally from the movement communicated to a tumour by a large vessel lying beneath it, which is simply a rise and fall. The extent and power of the pulsation in an aneurism depend usually upon the amount of clot in the sac; and thus the gradual decrease of pulsation may be watched from day to day, as an aneurism is becoming consolidated under the use of pressure.

Pulsation may be obstructed by clots lying about the mouth of the aneurism, and sometimes may be altogether absent, although the sac still contains fluid blood. These are the most difficult cases in respect of diagnosis, which is then inferential merely, and almost as obscure as in internal aneurism. The cause of the absence of pulsation in an uncured aneurism is often very obscure. In some cases it appears to be due to the obstruction of the mouth of the sac by loose coagula. In one case of popliteal aneurism, I thought that pulsation had disappeared in consequence of rupture of the artery and aneurismal sac during the use of flexion. A free rent in the sac, like the total rupture of an artery by violence, is usually accompanied by disappearance of pulsation. Sometimes the pulsation may even have disappeared, in consequence of the tumour having been spontaneously cured, and yet its size and interference with

the functions of the limb may cause the patient to apply for advice to a surgeon who has not seen it during its earlier stages. In such a case as this the patient's account of the previous symptoms, if he be a person of intelligence, will be of great value, while, if he can give no account of the disease, the diagnosis will probably be uncertain. Such was the case in the patient mentioned on p. 439.

The pulsation can be made to cease at once by pressure on the artery above the tumour—a character common, of course, to all tumours which derive their pulsation from the vessel, whether by continuity with it or not; whether aneurisms, enlarged glands, abscesses, or anything else pressing on the artery. Pulsation in an aneurism is always more powerful than in the arteries leading to it, while the sac contains much fluid. This is a consequence of the powerful reaction between the wave of fluid and the walls of the sac (see p. 425).

The gradual return of the tumour to its full size, after it has been emptied by pressure, the circulation having been stopped, is another feature very characteristic of aneurism; and it is important to note the variations in this respect, which will be observed in an aneurism as it is gradually filling with clot. The more fluid the sac contains, the more completely will it be emptied, and the more readily will it fill. As the deposit of clot proceeds, the beat becomes less forcible, and the tumour varies less in size on pressure upon the artery. It should not be forgotten, that since pulsation is caused by the reaction which the parts around exercise against the impulse of the heart, it depends for its perfection upon the integrity of the sac; hence it is frequently not present at all when there is no sac, as in rupture of an artery before a sac has formed. Thus, in a case where the patient had been caught by some machinery in motion, and the leg violently twisted, much ecchymosed blood was found in all parts of the limb below the popliteal space, but no pulsation ever appeared in this collection. The limb was amputated about a fortnight after the accident, on account of gangrene, when the popliteal artery was found broken completely across. So in aneurisms which, after advancing rapidly, suddenly burst with a large rent, the pulsation often vanishes completely; to recur, perhaps (if the accident is not fatal), when the rent has healed.*

* See also the case on p. 421.

Having clearly before us the symptoms of surgical aneurism, the following rules may be laid down for its diagnosis from each of the affections above spoken of.

Diagnosis of aneurism from tumours pressing on the artery.—

The greater number of tumours which lie against an artery do not cause any bruit. If they do produce any sound, it is a mere dull short beat, or ‘thud,’ as it is sometimes called, and may in these cases usually be imitated by pressing the stethoscope firmly on any large superficial artery. On the contrary, the bruit of an aneurism is usually a somewhat prolonged rasping or blowing sound, and cannot be artificially produced in a healthy artery.

The pulsation communicated to a tumour, or abscess, lying over an artery is an equable rise and fall, which ceases entirely when the pulse is stopped, and recurs at the first renewed beat of the artery as strongly as ever. The pulsation of an aneurism is generally a wave of fluid, which, on the removal of pressure from the vessel, does not attain its greatest height till after a certain number of pulses, and which causes not merely a rise and fall of the tumour, but also an expansion in every direction. The surest diagnostic sign, however, is, that the tumour can be dragged away from the vessel, while the aneurism cannot; but this is not always the case, since the tumour may be too deep, or too tightly bound down by fascia, or too closely adherent to the artery, to be moved. To this it may be added, that if the swelling be an abscess, the symptoms of that affection will sometimes be present; but the occurrence of suppuration around, or in, aneurismal sacs must be kept in mind; so that too great stress should not be laid upon the symptoms of suppuration, as if they excluded the notion of aneurism; and in any case in which there is doubt whether the swelling is an abscess or an aneurism, auscultation should be carefully used, since the rough aneurismal sound will prove that, even if it be an abscess, the swelling communicates with the neighbouring artery.*

* Great caution is needed in dealing with tumours lying near large arteries. Broca (p. 427) relates that of the four successive senior surgeons of Hôtel Dieu, Ferrand, Desault, Pelletan, and Dupuytren, the others each opened an aneurism by mistake for an abscess, and Pelletan laid open a malignant pulsatile tumour, intending to perform the old operation for aneurism. Mr. Erichsen has recorded three cases which came under his own notice at University College Hospital in which aneurisms had been treated as abscesses, and in two of the cases had been opened (*Lancet*, Oct. 7, 1868).

Pulsation may, however, be caused by the tumour being, as it were, enclosed in arteries. This was the case in a patient in whom Mr. Moore tied the common iliac artery, on account of a pulsating tumour situated exactly in the position of an aneurism of the external iliac artery, and having 'a rough and loud murmur.' On dissection it was found that the tumour was formed by cancer deposited in a mass of glands situated in the bifurcation of the common iliac between the internal and external iliac arteries, closely bound down to those vessels, and particularly to the external iliac, by an envelope of fascia, having the obturator artery beneath it, and perforated by the gluteal, sciatic, and pudic arteries. In this case, though the question of aneurism or pulsatile malignant tumour was discussed, it was found impossible to establish the diagnosis of its cancerous nature; nor, after death, could any means of diagnosis be suggested, except that the urine in the bladder contained cancer-cells, which might perhaps have been found by microscopic examination. But as the only specimen of urine which had been seen was quite clear, it is possible that the cancer-cells might have been only occasionally present; and it must be allowed that no means of certainly diagnosing such cases are known at present, since, from its shape and depth, the tumour separated the fingers as it rose, so as to simulate the expansive pulsation of aneurism, and the sound was not appreciably different from what is found in many aneurisms. Even had the tumour been more superficial, it was so surrounded and penetrated by large arteries, that its pulsation could not have been stopped by drawing it away. This was the fifth case in which the common iliac artery has been tied in London; and, out of these five, it was the third in which the disease was supposed to be of aneurismal, but proved to be of malignant, nature (*Med.-Chir. Trans.* vol. xxxv. p. 468). A case occurred in Mr. Paget's practice, which still more strikingly illustrates the difficulties of diagnosis which beset pulsating tumours lying near the large arteries in the abdomen. A man was admitted for pulsating tumour in the groin and iliac fossa. Much doubt existed as to its nature. Most of those who saw it inclined to the opinion that it was aneurismal; others thought it malignant. It was decided to cut down on the external iliac, and if the tumour appeared to be an aneurism and ascended too high to allow of this vessel being secured, then to tie the common iliac. The operation was performed accordingly; but the false pelvis was found filled with a large mass, partly solid, and not pulsating, which so displaced the arteries that it would have been hardly possible to tie the common iliac. However, under the impression that the tumour was malignant, the attempt was not made. The tumour fungated out of the half-healed wound of the operation, and the man died of arterial hæmorrhage. It was then found that the tumour was really aneurismal, and partly consolidated.*

Mr. South† mentions a case of varix of the internal jugular vein, preserved in the museum of St. Thomas's Hospital, which encircles the artery, filling nearly the whole side of the neck, and notices the difficulties which must arise in such cases in separating the pulsation of the tumour from that of the artery round which it is, as it were, folded. In the case of a varix, Mr. South thinks that it might be distinguished 'by

* *Brit. Med. Journ.* 1858. p. 524.

† *Chelius*, vol. ii. p. 202.

pressure of the swelling at its farthest extremity from the heart, in which case its size will diminish; whilst if pressure be made between it and the heart, its bulk must be increased, which is the very reverse to aneurism.*

Diagnosis between aneurism and pulsatile tumours of bone.—The diagnosis between pulsatile tumours of bone and aneurism is very difficult; so that many of our best surgeons have been deceived by the resemblance. The diagnostic symptoms are the following, but they are seldom or never all present together: 1. The bruit seems but rarely as well marked in pulsatile tumours as in aneurism, and is often altogether absent. 'It is true,' however, as Mr. Stanley remarks,† 'that in states of general anæmia, also in diseases of the aortic valves allowing of regurgitation, limited portions, or even the whole, of the arterial system, without organic change in the vessels, may impart to the stethoscope a murmur approximating to the bellows-sound of aneurism. And if, under such circumstances, a tumour should happen to form in any region of the body, so close to a large artery as to influence its pulsations, then, by the stethoscope, the bruit or bellows-sound may be recognised in the artery as forcibly as in an aneurism.' 2. The pulsation is usually more sudden, less heaving, and less expansive in the pulsatile tumour, and is equally forcible over the same space of tumour, whether the latter be large or small; while in aneurism the bulk of the swelling and the force of its pulsation increase and decrease together. 3. The condition of the bone with which the tumour is connected will often aid in the diagnosis. Thus, in Mr. Stanley's case (*Med.-Chir. Trans.* vol. xxviii. p. 318), a plate of bone was found in the walls of the tumour. In another, which I saw at St. George's Hospital, some years ago, where a pulsatile tumour of the ilium projected in the buttock at the situation of the sacrosciatic foramen, and closely resembled in many respects an aneurism of the gluteal artery, the diagnosis was correctly established by observing fulness in the iliac fossa, the ilium being expanded on both sides by the tumour developed

* A case will be found in the *Med.-Chir. Trans.* vol. xxviii. p. 314, in which Mr. Earle tied the subclavian artery on account of a supposed axillary aneurism; which, however, turned out to be a tumour connected with the median nerve. It is to be regretted that nothing is said about the symptoms beyond the general statement, that 'the tumour presented all the characters of aneurism.'

† *Med.-Chir. Trans.* vol. xxviii. p. 316.

in it.* When an aneurism, on the contrary, eats through a bone, it simply chisels out a hole in it; so that if the sac can be emptied and made to collapse, the edges of the hole will be felt.

4. These pulsatile tumours of bone appear to be always, and certain are usually, cancerous; so that the general symptoms of the cancerous cachexia may be present, or some other cancerous tumour may be seen. In the pulsating tumour in the buttock just mentioned, the presence of hæmaturia at a later stage of the case revealed the existence of mischief about the kidney, which was found after death to depend on the deposition in that organ of a large mass of encephaloid cancer. It must be admitted, however, that the diagnosis between pulsatile tumour and aneurism is often a matter of the greatest difficulty, even if it be possible; and that the diagnosis of cases of aneurism unaccompanied by pulsation, such as those mentioned on pp. 428, 447, is sometimes impossible.

Two cases which occurred lately at St. George's Hospital illustrate (among a great many which might be quoted) the difficulties which beset the diagnosis between aneurism and pulsatile tumour of bone. One was the instance of aneurism of the ulnar artery caused by impaction of clot, figured on p. 422. In this case no operation was proposed, as the boy was in an advanced stage of cardiac disease, but the case was shown to the surgeons in consultation, and the appearance of thickening around the ulna in the neighbourhood of the tumour led the majority to regard the case as one of pulsatile cancer. The second case was one in which almost all the symptoms of popliteal aneurism were present, though not very well marked—there being a distinct though not loud bruit, and an expansive pulsation, though not a very powerful one. It was thought more probable that this was a case of aneurism, in which the sac was partly full of soft clot; and although the possibility of pulsatile tumour was not denied, it was decided that the artery should be tied, pressure having been previously tried without benefit. The patient died some weeks afterwards of phlebitis, and it was then found that the disease was pulsatile cancer of the femur.

Diagnosis between aneurism and aneurismal dilatation.—The diagnosis between an aneurism and a mere dilatation is usually quite obvious, at least between extreme examples of the two. The dilatation is generally unaccompanied by any distinct tumour or by any aneurismal bruit. It contains no clot, and hence may be completely emptied by pressure on the artery above, filling at once when that pressure is removed; and there is usually no interference with the pulse in the arteries below the disease.

* In Mr. Stanley's case also the tumour projected on both sides of the ilium.

TREATMENT OF ANEURISM. THE OLD OPERATION.

The medical treatment of aneurism has been discussed sufficiently for the purposes of a work on surgery. It now remains for us to consider the various plans of local treatment which are in use in ordinary or encysted aneurism, and to point out, as far as our present experience enables us to do so, to what extent and in what cases each plan is likely to prove useful.

The first method of treatment, usually called the old operation, or the method of Antyllus, aims at the entire eradication of the aneurismal tumour.* The operation is thus performed: the artery above the seat of aneurism is to be commanded, if possible, by a tourniquet, or by the finger of an assistant; then an incision is to be made into the tumour, care having been taken to expose it by a sufficient dissection of the superficial parts, should these involve any important structures; the clots are then to be rapidly turned out of the sac, and the orifice by which it communicates with the artery is to be searched for; a ligature is then to be placed on the vessel above and below† the aneurism. The opening of the vessel can be found by passing a probe from the sac, first upwards and then downwards, in cases where a distinct sac is found; but in 'diffused' aneurism this is often impossible, according to Pelletan. When the ligatures have ulcerated through the vessel, and the cavity has been filled up by suppuration and granulation, the tumour is radically extirpated.

Such is the description, in general terms, of an operation which, thus stated, appears simple enough. Its difficulties, however, are often of the gravest character when the aneurism

* Perhaps I ought to mention another method of eradicating an aneurism, viz. by caustic. Thus Nélaton destroyed a small bleeding tumour, resulting from a ruptured traumatic aneurism of the palmar arch, by means of chloride of zinc (*Journ. de Méd. et Chir. prat.* May, 1862). This method, however, can only be used on superficial tumours of small size and connected with small arteries.

† Keyslère, a surgeon of Lorraine, but practising in Italy, and who appears to have reintroduced the method of Antyllus into Italy, used only one ligature above the tumour. Three of his cases are reported by Testa of Ferrara (who seems to have learnt the operation from him), of which two were successful. Mazotti, who had seen Keyslère operate, used two ligatures generally, but not always (Pelletan, *Clin. chir.* vol. i. p. 142).

is deeply seated, when the artery communicates with its deepest part, and when the sac contains recesses or is closely united to the parts around. Besides its difficulty, it is often an extremely severe operation, requiring an incision of extraordinary length,* necessarily involving considerable hæmorrhage, and leaving an enormous cavity to fill up. The records of ancient surgery show that it used to be often a tedious and desperate proceeding, which sometimes proved fatal on the spot, and the success of which was at all times very uncertain. Hence it has been superseded in almost all cases, and few living surgeons have much experience of it. In popliteal aneurism, for which it used to be the only cure except amputation, it is now completely abandoned, having given place to milder and more certain methods. In femoral aneurisms, compression or the ligature of the external iliac would always be preferred; and so on for most of the common species of surgical aneurism. There are, however, some situations in which the old method still holds its ground in the estimation of at any rate some surgeons. In axillary aneurism it has lately been recommended by the high authority of Mr. Syme, and enforced by the example of his successful application of it. In aneurism of the gluteal artery, should that rare disease be met with, many surgeons would prefer cutting down on the sac and turning out the clot, especially in a traumatic aneurism, to the still more dangerous operation of securing the internal iliac artery;† and in traumatic aneurism at the bend of the elbow, if the disease resisted the proper application of pressure, it would perhaps be considered more safe to open the sac and tie the artery above and below, and would involve no more danger to life. Besides these, cases will every now and then be met with in which the diagnosis having been uncertain the tumour is cut into with a view to tying the artery above and below it, if it prove aneurismal, or amputating, if it be cancerous.‡ In some cases also

* In a successful case, Pelletan made an incision ten inches long in operating on a recent popliteal aneurism, which is not stated to have been of remarkable size.

† But the diagnosis must be made with certainty. See above, pp. 452, 454. In Mr. Syme's *Observations in Clinical Surgery*, 1861, pp. 165-173, will be found two interesting cases of gluteal aneurism, treated, one by the old operation, the other by ligature of the internal iliac artery, and both with success.

‡ Gay, *Lancet*, 1868, vol. i. p. 780.

after the bursting of the sac the artery can be secured in this way and amputation avoided.*

The leading idea of the old surgeons in operating upon aneurisms was doubtless an erroneous notion that it was necessary to get rid of the clot, which they believed to have vicious properties, and to be injurious both to the part in which it lay and to the constitution of the patient. So that they turned it out, not merely that they might find the mouth of the artery, but also, and mainly, in order to rid the constitution of so dangerous a secretion; and stuffed the cavity with compounds which they believed to have the property of preventing the reproduction of coagulum. All this theory is of course exploded now; and if the operation were undertaken in any case where there was much clot, the only object of the surgeon in disturbing that clot would be to find the mouth of the sac. Still, when the clot has been disturbed and exposed to the air, it is better to remove it; and thus a large cavity is left to be filled up, and the extensive suppuration which this involves accounts for a large percentage of the great mortality after this procedure. Gangrene was very common after the old operation for popliteal aneurism, possibly from the difficulty of distinguishing the parts from each other, and the consequent frequency with which the vein and sometimes the nerve also was included in the ligatures. Another and a very frequent cause of death was the great liability to secondary hæmorrhage involved in this method as it used to be practised on diseased arteries. When used for traumatic aneurism, this objection does not apply, since the artery is as likely to be healthy in the neighbourhood of the wound as in any other part; but spontaneous aneurism usually occurs in consequence of atheroma in that part of the vessel; it is probable, therefore, that the ligatures will be applied to a brittle, degenerated artery, and will cut it through before any union has taken place. This danger, it is true, accompanies the Hunterian operation also, though to a less extent,† and there is more probability of finding the coats of the artery near the tumour sufficiently healthy for the application of the ligature in external than in internal aneurism; but even in the arteries of the limbs the neighbour-

* Birkett, *Med.-Chir. Trans.* vol. 1. p. 431. Cooper Forster, *Clin. Soc. Trans.* vol. i. p. 36.

† Especially in the arteries of the belly. See the account of an operation on the external iliac artery by Sir W. Fergusson, *Med. Times*, vol. ii. 1855, p. 567. See also *infr.* on Abdominal Aneurism.

hood of the tumour is the most insecure place at which an operation can be practised ; and this was the main theoretical reason which set Hunter upon thinking of a new operation for aneurism.* The practical reason was doubtless the excessive mortality occasioned by the above-mentioned causes, and by the hæmorrhage during operation, which, in all cases where no tourniquet could be applied, was frightful, and sometimes instantly fatal,† and which was often severe even when the artery was commanded above the tumour, since, in a deep sac, it was necessary to let the vessel bleed in order to find its mouth. What the mortality was after this operation, practised as it usually was in the popliteal space, we have no means of judging, except by consulting the works of those surgeons who, like Pelletan and Roux, have left the records of their individual experience ; and it cannot be too often repeated that such data, though useful in many respects, are untrustworthy as statistics. Statistics of operations to be of any use or authority must be founded not on cases arbitrarily selected for publication, not even on the individual experience of distinguished operators, however fully and frankly given to the world, but on the general experience of large hospitals, embracing every case indiscriminately for a long series of years.‡ This has never yet been fully effected, and till a very few years ago was entirely unthought of. The mortality of every operation in ancient times must have been high, since the after-treatment was far more arbitrary and artificial than at present ; but what the

* ‘Mr. Hunter, finding an alteration of structure in the coats of the artery previous to its dilatation, and that the artery above the sac seldom unites when tied up in the operation for aneurism, so that as soon as the ligature comes away, the secondary bleeding destroys the patient, was led to conclude that a previous disease took place in the coats of the artery. . . . Mr. Hunter, from having made these observations, was led to propose that the artery should be taken up at some distance from the diseased part, so as to diminish the risk of hæmorrhage, and admit of the artery being more readily secured, should any such accident happen. The force of the circulation being thus taken off from the aneurismal sac, the progress of the disease would be stopped ; and he thought it probable that if the parts were left to themselves, the sac with its contents might be absorbed, and the whole of the tumour removed, which would render any opening into the sac unnecessary.’ (Hunter’s *Works*, vol. iii. pp. 596, 598.)

† Roux, *Quarante Années*, &c. vol. ii. p. 46.

‡ If it were possible to obtain reliable and unselected data from private practice, they would of course be equally useful ; but this as yet has not been found possible.

proportion of deaths may have been we cannot now ascertain. Pott, in the well-known passage referred to on p. 442, says of this operation : ‘ I have tried it myself more than once or twice ; I have seen it tried by others ; but the event has always been fatal : ’ and Wilmer of Coventry said that in the year 1780 there had not occurred in this country one well-authenticated case of success. However, in Pelletan’s *Clinique chirurgicale* (vol. ii. pp. 117-144) there will be found notes of four operations of his own and six practised in Italy, in which success is claimed in no fewer than seven cases ; and in Roux’s *Quarante Années* (vol. ii. p. 468) the only two recorded cases of the operation on the popliteal or femoral artery by opening the sac were successful. It is probable, therefore, that Pott’s view of the mortality of the operation was too gloomy ; although the immediate success of the introduction of the Hunterian operation shows that the old method must have been far more fatal. Now the Hunterian operation on the femoral artery, as practised at present, gives, as we shall see, a mortality equal, or nearly so, to that of amputation of the thigh ;* consequently the proportion of deaths after the old operation must have been something frightful.

The risk of hæmorrhage during the operation is a very formidable one when no tourniquet can be applied. Mr. Syme, however, has succeeded in several cases in getting through these dangerous operations without fatal hæmorrhage by the same expedient as he uses with such success in tying the vessels for wound ; a proceeding to which the operation under consideration bears much analogy. He opens the sac at first by a moderate puncture, which allows him to introduce a finger into the sac and feel for the opening of the vessel. If the puncture is not large enough, he dilates it so as to get in one and another finger,† until the point is discovered at which the pressure of the fingers arrests bleeding. Meanwhile the opening in the skin is of course plugged by the fingers which have been thrust into it, so that no great gush of blood takes place. When the orifice of communication between the sac and the vessel has thus been commanded, the sac is opened freely and cleared of clots. Then the vessel is raised with forceps, if it is fairly

* I do not, of course, mean that the operations are equally severe ; but that about the same number of patients die after each. This is probably to be accounted for by the state of the circulating system and of the constitution which gives rise to aneurism.

† In one case the whole hand was inserted up to the wrist.

visible, and tied. If the artery is not exposed, the operator must keep his finger still pressed on the orifice, while, with the aid of his assistants, he scratches away the tissues that obscure it.* Further reference to these operations will be made in the sections treating of Carotid, Axillary, and Gluteal Aneurism.

THE HUNTERIAN OPERATION BY LIGATURE.

The treatment of popliteal aneurism by ligature is one, and perhaps the most perfect, of the many discoveries of modern surgeons.† It reduced a disease, which before was almost uniformly fatal, to the position of one of the most manageable of all serious surgical affections. It is true that in still more recent times a method has been discovered which is usually successful at even less risk to life; but this method of compression, though, as we shall see, it may commonly be reckoned upon in popliteal aneurism, may fail even there, and there are many arteries to which it is inapplicable; so that the Hunterian operation of tying the artery above the sac still is, and probably will long remain, the last resource of surgeons in the graver cases of aneurism. Of so great a discovery and so happy a triumph of our art over difficulties which we, who have been taught how to combat them successfully, cannot estimate in their full magnitude, the history is always interesting, and the right appreciation of the claims of rival inventors is a matter of no slight importance. Unfortunately the limits of the present work do not allow of an adequate discussion of this subject, so that all that can be said about it must be comprised in a very few words, and it is more with a view of avoiding ambiguity or difficulty in reading foreign books, than of writing a portion of the History of Surgery, a task which is not attempted in the present work, that the following brief account is inserted of the rival claims of Hunter and Anel to the honour of giving his

* A good description by Mr. Erichsen of this operation will be found in the *Lancet*, 1868, vol. ii. p. 504.

† It is not intended to assert that the practice of tying arteries is a modern invention. 'The Greek and Arabian physicians,' says Mr. Hodgson (*op. cit.* p. 187), 'more especially *Ætius* and *Paulus* of *Ægina*, distinctly recommended the ligature of the brachial artery a few fingers' breadth below the axilla for the cure of aneurism at the bend of the arm.' But, like many surgical inventions of the ancients, it had been lost until its reintroduction by modern surgeons in a more complete and more practicable shape.

name to the operation now in use. This operation consists in securing the artery by a single ligature at a distance from the sac, and between it and the heart. The student will always bear in mind in reading most of the modern French works on surgery, that they intend by the 'méthode d'Anel' the same thing as English, German, Italian, and American writers do by 'the Hunterian operation.' The essential difference between Hunter's and Anel's methods has been shown so often and so clearly, that although I think it necessary again to expose it in this place, this will be done only cursorily, and as little space as possible will be wasted upon a question which has become rather personal than scientific.

The old method of operating for aneurism has been discussed, and its radical error has been seen to be, that its authors confounded what is in reality the effort of nature for the cure of the disease, viz. the deposit of laminated fibrine, with the essence of the malady itself; and instead of striving to encourage and promote this deposit, thought it necessary to undertake a severe operation for the purpose of removing all such clots from the system. Another, and hardly less fatal objection to its general application, was, that as the old surgeons never contemplated the possibility of a cure of the aneurism without the entire suspension of the circulation, it was necessary, in their view, to tie the artery close above the tumour, and, this having been done, it was found out that the blood would usually escape from the lower end unless that was also tied.* The great merit of Hunter consists in his having avoided both these errors; in his having seen, *first*, that it was not necessary to turn the clots out of the aneurismal tumour, so that no incision was required to open the latter; and *second*, that it was not necessary to stop the circulation through it absolutely, but only, as he said, 'to take off the force of the circulation,' so that the artery might be taken up some distance from the sac, and therefore at a part where it would probably be found healthy; and further, in his perceiving that the ligature of the main artery of the limb does not involve the gangrene of the extremity, but that the anastomosing vessels may be trusted to carry on the circulation.†

From these considerations Hunter was led to propose the ligature of the artery at a point some distance above the sac for the cure of aneurism, the result of disease; and that he, at any rate, and his contemporaries thought that he was making a proposition of startling originality, is clear from the terms in which Hunter cautiously recommended it in his lectures, and from those in which Bromfield commented upon what appeared to him its rashness and its dangers.‡ That it was equally new to Anel's countrymen (although seventy-five years had elapsed since Anel's day, during which the operation

* But some of the old operators used, as we have seen, one ligature only (p. 456, note). This fact should not be forgotten, as bearing on Anel's claims to originality in his invention.

† This had, however, been previously taught by Haller (quoted in Scarpa, Wishart's trans. p. 229).

‡ See Hunter's *Works*, vol. i. pp. 547 et seq.

devised by him might have been expected, had it rested upon any new principle, to revolutionise surgery), is equally clear from a perusal of the pleasant work of Roux.* We read there, that while in England the great school of Hunter, and in Italy, Paletta, Vacca, and Scarpa, had everywhere spread abroad the use of the Hunterian operation, the old method was gaining ground more and more firmly in France, until M. Roux himself, after his return from England, reimported Hunter's operation, which, as we shall see, had been performed once by Desault. In fact, he says that it was not without astonishment that the Paris surgeons heard of a practitioner at Angers having been rash enough to apply Hunter's method to a *traumatic aneurism in the bend of the elbow*; the very case on which Anel had operated. So utterly had the memory of this reputed discovery perished with its author. It may, however, be replied that, though Anel's operation failed to attract the same notice as Hunter's, this does not prove that they are not identical in principle; nor does it. Even if it were so, however, there would be no little injustice in passing silently over the merits of the man who excogitated the principle by profound reasoning, applied it in spite of searching hostile criticism, explained clearly the theory on which it rested, and succeeded thus in forcing the world's attention and imitation in favour of one who was quite ignorant of the true principles on which the cure of the disease must be founded, and who, for anything that appears to the contrary, was guided by pure chance to the selection, on perfectly false principles, of an operation which he never repeated, nor persuaded others to repeat. This would be so, had Anel even happened to stumble on the same operation as Hunter; but the truth is, that the operations are perfectly different,† and rest on different principles; and that while the one will probably succeed, the other will almost certainly fail in many cases where the aneurism is the result of disease.

The case on which Anel operated has been often quoted, and is very well known. It need not here be related at length. The facts were these: a man had received a wound of the brachial artery in venesection. It is said that a fortnight afterwards an aneurism formed, and the wound reopened and gave rise to hæmorrhage, which was arrested by compression; and that after this, the tumour became very voluminous. What length of time had elapsed, and what the state of the tumour was, when Anel undertook his operation, we are not informed. The operation consisted in exposing the brachial artery, tying it as near the tumour as possible, and applying 'the proper dressing and

* *Quarante Années*, &c. vol. ii. p. 89.

† No better proof of the radical difference between the two operations can be required than is furnished by comparing two consecutive pages of a writer who persists in calling Hunter's method the '*méthode d'Anel*;' see pp. 509, 510 of M. Broca's work. In the former page he is carefully and judiciously explaining the essential difference in their effect on the collateral circulation, and hence on the patient's chance of recovery; in the second (the passage commencing '*études maintenant*'), he has recurred to his habitual language, and speaks of them both under one common designation. To such an extent is this pedantry of error carried, that it is difficult at first to see that in the latter passage the common or Hunterian operation is spoken of under the name '*méthode d'Anel*;' while in the former the same term signifies the now disused proceeding which that surgeon adopted.

bandage.' We are not told expressly whether the blood in the sac was solid or fluid; but it appears clear that it was in the latter state, and that the only reason which Anel had for not opening the sac, and emptying it of its contents, was that he was able to empty it by pressure. That this was so, appears implied in his own observations on the subject. He says: 'Instead of tying the artery above and below the tumour, I only tied it above; and besides, instead of opening the sac, I did not meddle with it; not doubting that the blood which it contained would disappear, having the opportunity of passing towards the extremity of the limb, and that the sac once emptied would not fill again, but its tissues shrivel up, and the tumour thus disappear: and all this occurred as I expected.' It seems clear, then, that if Anel expected the blood in the sac to pass on towards the hand, that blood must have been fluid, and probably the 'suitable dressing and bandage,' which he says he applied after the operation, may have had quite as much to do with the cure as the ligature of the artery; and, after all, the case may have been cured by direct pressure, an event not uncommon in recent traumatic aneurisms at the bend of the elbow. This is evidently quite a different operation from Hunter's; the only principle it has in common with his, is that of leaving the sac unopened; and few persons who read without prejudice Anel's confused and obscure account of his operation, will fail to see that the reason of his not meddling with the sac was most probably that it could be emptied by pressure. This view is again supported by the fact that Heister, who followed Anel's account, and apparently spoke on the authority of his single case,* advised its application only in 'reducible' aneurisms. Thus it does not appear that there was much of novelty in Anel's method, since it merely consisted in leaving to the fluid contents of the tumour an exit by the lower end of the artery instead of tying the latter, just as Keyser had done; and it may very fairly be doubted whether what novelty there was, was not a mistake,† and whether Anel's case, in spite of its success, is not only another instance of haphazard good fortune. At any rate, the results which flowed from it before the time of Hunter did not seem to testify to the brilliancy of the discovery. The great learning and evident bias of M. Broca have only enabled him to adduce what he calls six instances of operations performed on this plan before the date of Hunter's first operation, a period of seventy-five years. Two of these are related in the loosest way by Bertrandi, as having occurred in the practice of some anonymous surgeon, and were failures. Of the others, one was of the temporal artery, and two others of the humeral, all most probably traumatic, and all very likely curable without difficulty by very simple means. The sixth case is the celebrated operation of Desault. It would be impossible, without taking too much space from more important matter, to discuss this operation fully in its bearings upon the Hunterian method. It is sufficient to say, that it was performed on a case of popliteal aneurism of small size, strictly after the method of Anel, *i.e.* by tying the artery immediately on its entering the sac. It appears (notwithstanding what has been said to the contrary) to have been successful, at least in its immediate results: the ligature separated on the

* Heister, *Instit. chirurg.* pars ii. sec. i. ch. xiii. § 20, Amstelod. 1739, quoted by Broca, p. 446.

† It seems as if Anel expected that the sac would empty itself, and would not again be filled; being ignorant of the reflux current and of the cure by coagulation.

eighteenth day; the tumour burst and discharged its contents on the day following; this wound healed, and the tumour disappeared. The patient died eleven months afterwards of a disease of the tibia, which appears to have been totally unconnected with the operation. This, then, was precisely the same as Anel's operation, and therefore missed the second and third principles * illustrated by the method of Hunter; viz. that the artery may be tied at such a distance as still to allow circulation through the tumour, and that the previous increase of collateral branches is not necessary to avoid gangrene, and that therefore the artery may be tied at the most convenient spot.†

The practical objections to Anel's method may be thus summed up. It leaves no current through the aneurism except the slight and weak reflux flow from the artery below. Consequently the clot formed will most likely be soft and loose, and the tumour will suppurate. It places under the ligature a part

* See p. 462.

† It would be unjust to deny the merit of Desault in applying the almost forgotten method of Anel to the treatment of that most formidable affection as it then was), popliteal aneurism, and still more unjust to deny that the experience thence acquired might possibly, had he survived, and had Hunter not been in existence (in fact had all the circumstances been altered), have conducted him to Hunter's discovery; but it is monstrous to set up Desault, as M. Broca wishes to do, as the rival of Hunter, when, according to his own showing, Desault himself was quite content to pass as Hunter's scholar. 'With a self-abnegation,' as M. Broca amusingly says, 'which his English detractors have been unable to appreciate, this great surgeon, who then had become acquainted with the operation practised by Hunter, did not hesitate to adopt the precepts taught by his illustrious rival' (p. 454). Desault, in fact, was unware of his title to the glory which M. Broca claims for him. As to the insinuation which M. Broca ventures to make, that Hunter was indebted for his operation to Desault by means of Assalini, who, according to him, was present at Desault's operation, and related its details to Hunter shortly afterwards in England, it refutes itself. The Hunterian operation was taken up nowhere more warmly than among the eminent Italians who were proud of being of the Hunterian school, as we have seen above from the contemporary account of M. Roux. Had one of their number conveyed to Hunter from Paris the first idea of the operation for aneurism, we may be quite sure that he, or some of his compatriots, would have said so. Assalini, an Italian surgeon, was the only person present, as far as we know, both at Desault's operation and at the first operation of Hunter. It was mainly through Assalini that the new method of treating aneurism was brought into vogue in Italy. Assalini and all other Italians always speak of that method as Hunter's. Would this have been so, had Assalini taught it to Hunter from what he had himself learnt of Desault? But the fact seems to be, that Desault's operation, which was not brilliantly successful, and which he did not put forth as original, attracted little attention from himself or anybody else; and that he had no desire, as he had certainly no right, to claim any priority over Hunter, whose teaching he, on the contrary, followed with great intelligence and great success in the single operation which he had subsequently an opportunity of practising.

of the vessel, which is more likely to be diseased than any other portion. It is, in most cases, the most difficult of all methods of operation, since the artery is pressed back by the projection of the tumour, and is therefore at an unnatural depth,* while the operator has not the guide for finding it which a probe passed out of the sac would furnish. For all these reasons it seems that in any case where Anel's method was feasible, the old operation would be equally practicable, and more certain of success.

The foregoing observations will, it is hoped, suffice to justify the use in the context of the name of Hunter in describing the operation which he is not denied to have invented in the form in which alone it is now practised, to have first performed, and to have afterwards, in spite of much opposition, introduced into general favour. If these things do not give claim to an invention, it is hard to see how such an honour is to be attained.

The Hunterian operation consists in tying the artery on which the aneurism is situated at any convenient distance above the sac. The operation, as it is now practised, differs in many important particulars from that which Hunter used to perform; particulars which have a most material influence upon its success, and which were impressed upon Hunter himself, and upon his scholars and successors, by the teaching of experience. Thus, Hunter used to tie the femoral artery at its lower part (in the fibrous sheath, called from that circumstance 'Hunter's canal'), an operation much more difficult and dangerous than the modification introduced by Scarpa.† Hunter, in his first operation, brought a large part of the walls of the artery into contact by four broad ligatures, somewhat loosely fastened, conceiving this disposition to be more favourable to the closure of the artery, which he described as taking place by the process of 'first intention.' His own experience, however, soon taught him to modify his form of ligature, and to use only one string; and the more extended experience and research of his successors (among whom Dr. Jones‡ has deservedly obtained

* I exclude the comparatively rare case of the artery being raised and flattened by an aneurism growing into the deep parts. But here also I should imagine that the difficulty of distinguishing the vessel would incline the operator to resort to the opening of the sac.

† On this head, see the section on Ligature of the Femoral Artery.

‡ On *Hæmorrhage*. Reference may also be made to Lisfranc: 'Thèse de concours des diverses méthodes et des différens procédés pour l'oblitération des

the first place) have proved to demonstration, that the best form of ligature is a single stout thread, drawn tightly: accordingly no other form is any longer in general use.* Lastly, Hunter was not at first at all careful to avoid including the vein with the artery in the ligature; but this was an error which he

artères dans le traitement des anévrismes,' Paris, 1834; South's *Chelius*, vol. ii. p. 219; Porta, *Delle Alterazioni patologiche delle Arterie*, &c., Milano, 1845.

* In the *American Journal of the Medical Sciences*, Oct. 1859, p. 570, will be found a very interesting case, in which Dr. Warren Stone, of Louisiana, tied the common iliac artery with a silver ligature. The ligature was not drawn tight enough to cut through the internal coats of the artery, according to Dr. Stone's judgment; the ends were cut short and turned down, and so left. The patient died, apparently of causes unconnected with the operation, on the twenty-sixth day; but the symptoms after the operation are not fully given. The ligature, however, seems to have fulfilled its purpose. The body unfortunately was not examined, so that the condition of the ligature was not ascertained. It seems to have been intended by Dr. Stone to remain on the vessel permanently, without exciting any ulceration, and therefore without inducing risk of secondary hæmorrhage. That this will sometimes, at any rate, be the case, appears by an instance in which I tied the femoral artery for aneurism after the failure of compression. The artery was enclosed by a silver wire drawn just tight enough to arrest the pulsation of the tumour, then twice twisted and cut off short. The wound did not unite by first intention, but the suppuration which took place beneath it was transient; the ligature never came away, and the man left his bed on the fifteenth day after the operation, the wound having been healed several days before. But if the ligature be drawn too tight it will cut the coats of the artery more than a silk thread would do, and I have seen a case in which secondary hæmorrhage rapidly followed the application of a silver ligature. Hence great care is required, in using such ligatures, not to employ too much force.

Professor Lister has recently introduced into practice the method of tying arteries with catgut steeped in carbolic acid—'the antiseptic ligature,' as he calls it. Sufficient experience has hardly yet been obtained of this method to justify an opinion concerning it. In a case under Mr. Spencer's care, where a ligature of this kind was under the carotid artery, it was said to have untwisted—though as to this there was some dispute. In a case of amputation under my own care, the popliteal artery was tied with this form of ligature. No secondary hæmorrhage took place. The patient (who was in very bad health at the time of operation), died seven days after the operation. I found the ligature perfectly loose; the lips of the cut end of the artery were in apposition, but there was very little coagulum in the vessel. Similar ligatures have, however, been used in many other cases with perfect success. I need hardly refer to the many times in which animal matter has been used experimentally in tying vessels. I should perhaps mention, that in one case where Mr. Lister had tied an artery with this catgut, he believed that he found the materials of the ligature several months afterwards in process of organic connection with the parts around.

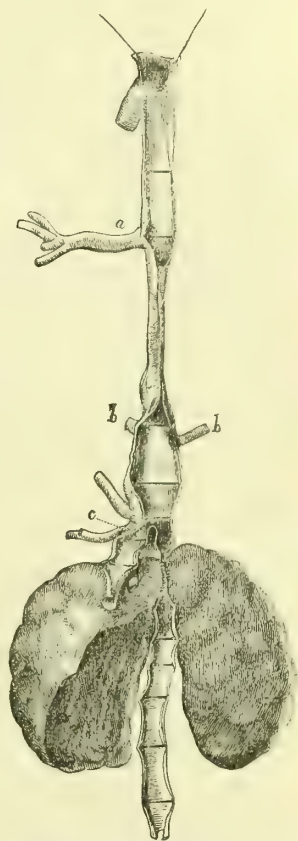
soon gave up. So that the more material improvements were devised by Hunter himself; and in principle the first operation which he performed was identical with all that succeeded it.

The effects upon an artery of the application of a ligature have been already detailed in a previous section of this work (see vol. i. pp. 736 et sqq). While the changes there described are going on in the artery itself, the process of cure is progressing in the aneurism. We have seen already, that on the withdrawal or diminution of the force of the circulation, the preponderance of the heart being abated, the process of spontaneous cure commences. The ligature acts to a certain extent as Valsalva's method acts; that is to say, it diminishes the force with which the blood distends the sac, and thus gives opportunity for the coagulability of the blood and the resilience of the parts to fill the sac with firm laminated clot, and so effect the cure of the disease. It differs, however, from Valsalva's method in this important particular—that its action is local instead of general, and is therefore incomparably more certain and more safe. As the process by which the aneurism is filled, and the changes which it afterwards undergoes, are to a great extent the same after ligature as in the natural process of cure, the reader is referred on that head to what has been said above. But to that account it must be added, that since the surrounding parts are suddenly relieved from tension by the withdrawal of the expansive force of the aneurism, their resilience, and the compression they exercise upon the tumour, play a much more important part in the cure after ligature than in the spontaneous cure.

While the aneurism is becoming consolidated, the collateral circulation is enlarging, to convey the blood into the parts below the ligature. The meaning of this term is as follows: when an artery has been tied at any given spot, the next considerable branch which leaves it above the seat of the operation, and in their degree the branches above this, feel an increased pressure, in consequence of the neighbouring column of blood having been barred in the principal vessel. Hence they yield to the increased impulse, and become distended. The collateral arteries, by means of which they anastomose with the branches of the parent trunk below the ligature, increase, and increase probably in a much greater ratio than the larger vessels, in proportion to the greater tenuity of their coats. The facility with which the capillary and other small vessels,

allow of changes of volume is well known.* Thus a ready way is opened for the blood to return into the parent trunk below the seat of ligature. To make this clear by an example: say that the femoral has been tied (as it generally is) some distance below the origin of the profunda, in a case of popliteal aneurism. The blood will distend the profunda artery and its branches, amongst others the external circumflex and its descending branch; which, joining with the superior external articular, and thus with the anastomotica magna, will be one of the arteries to convey the blood round the ligature back into the trunk of the femoral, below the obliterated spot. The number of such collateral arches of anastomosis is uncertain, but probably they are numerous in most cases, and include, not named arteries only, like that above adduced as an example; but a number of muscular and other branches, the anastomoses of which are so fine in the healthy state, that they escape our ordinary methods of

FIG. 160.



* The enlargement of the collateral vessels must depend upon the presence of some oxygen in the blood, as well as the sufficiency of the vis a tergo of the heart. If the former be absent, there is no attraction of blood to the capillaries in the distant part of the limb; and a local asphyxia, followed by gangrene, must ensue. Deficient vis a tergo would show itself by pallor and coldness, with shrinking of the distal parts; a defective capillary attraction, with sufficient vis a tergo, would be shown in a stationary venous condition, perhaps livid congestion of the limb; while if the vis and the attraction be both wanting, the limb must be simply cold and inactive—in fact, dying. The integrity of the walls of the anastomosing vessels is also an important condition in the restoration of the collateral circulation.

Cure of femoral aneurism by ligation of the external iliac. The artery is seen to be obliterated for some distance at the seat of ligature: *a*, *bb* show the enlarged collaterals on either side of the ligatured portion. The artery is again obliterated for a short distance near the aneurism; *c* points to enlarged collaterals, one of them of very large size, probably the profunda. The artery is seen to resume almost its natural size just below the aneurism. (From a preparation in St. George's Hospital Museum, ser. vi. No. 120.)

injecting.* The accompanying representation of a specimen in the Museum of St. George's Hospital, from a case of femoral aneurism, illustrates most of these points, allowance being made for the difference of the arteries involved in the changes.

The rapidity with which this process goes on cannot well be ascertained in the human subject. In animals it is known to be very rapid;† but in animals the process of repair in all

* The number of anastomosing branches varies considerably. Porta (op. cit.) figures a preparation in which he found between fifty and sixty. On the other hand, there is a preparation in the Museum of St. Thomas's Hospital, in which the blood is brought down from the upper to the lower part of the brachial artery by a single branch the size of a crow-quill. Sir Astley Cooper states, probably referring to this preparation, as well as to that of a man whose thigh he amputated some years after an operation for popliteal aneurism, that although the anastomosing vessels which enlarge immediately after the operation may be numerous, their number afterwards diminishes, those less necessary yielding their place, as it were, to a few, or perhaps to a single vessel, which may be found nearly in the place and nearly of the size of the original trunk. (Wardrop, op. cit. p. 12; see also *Med.-Chir. Trans.* vol. xxv. p. 117.) Two beautiful plates, the back and front view of a preparation in which the collateral circulation has been injected after ligature of the femoral, may be seen in Porta's work. The very free communication between the external circumflex, superior external articular, and anastomotica magna, is very clearly shown. There is also a large and direct arch of anastomosis between the latter artery and the internal circumflex. Thus the femoral and popliteal above the aneurism have been kept pervious, while below the aneurism the blood enters the popliteal by two great branches (inferior articular), which receive their supply from a large arterial network in front of the joint, derived from the arteries above mentioned (viz. profunda, anastomotica magna, external circumflex, and superior articular): a direct communication from this network to the tibial recurrent appears also to have reinforced the anterior tibial.

† See the experiments of M. Broca, op. cit. p. 507, note. He placed a ligature under the femoral artery of a dog in the groin; then amputated the leg at the knee, and noted the distance to which the pulsating jet extended, both during the systole and diastole of the heart. The ligature in the groin was then tightened, by which, of course, the bleeding was stopped for the time; but it recommenced from the popliteal artery at the end of one minute, and at the end of five minutes the jet (which, however, no longer pulsated) had attained a quarter of its former maximum, even though the quantity of blood in the body was less. In an interesting case reported by Professor Otto Weber in the *Deutsche Klinik*, 1867, p. 285, he extirpated a tumour from the thigh. The femoral artery was so closely connected to the tumour, that after dissecting it as it went into the tumour above, he tied a ligature on it. He did not divide the artery then, but proceeded to dissect the vessels at the lower part of the tumour. Having exposed them, he placed a single ligature round both the artery and vein, without tightening it. The artery was noticed to pulsate strongly, and when opened, bled almost as fiercely as if it had never been tied. Then the ligature was tied, and the tumour

injuries of vessels is very far more active than in men, so that in them gangrene never follows on the ligature of arteries. No sound conclusions, therefore, can be drawn from this experience. In men, however, the process seems to advance sometimes very rapidly in the upper extremity, where the natural anastomoses are free. Thus, in Anel's celebrated case, it is stated that the pulse could be felt at the wrist on the day after the ligature of the brachial. In Mayo's case of ligature of the subclavian,* the pulse was felt at the wrist on the fifth day, but disappeared afterwards; and in a case of popliteal aneurism operated on by Deschamps, pulsation was, it is said, felt in the sac seven hours after the operation.† On the other hand, in a case where the present writer had occasion to tie the axillary artery during an operation, the patient being a child, no pulse was perceptible in the radial more than a year afterwards. The enlargement of the collaterals has taken place to some extent before the operation in most, if not all, cases of aneurism, being occasioned by the obstacle to the circulation caused by the aneurismal tumour. The readiness of the return of pulsation will depend in a great measure upon the agents by which the circulation is

removed with more than two inches of each vessel. The precise time between tying the upper end of the artery and opening the lower is not given, but could not have been many minutes. The patient recovered perfectly. In this case, as Professor Weber remarks, the collateral circulation had been doubtless enlarged by the pressure of the tumour on the main trunk.

* *Med.-Chir. Trans.* vol. xvi. p. 363.

† Wardrop remarks on this head: 'The enlargement of the anastomosing vessels, to a certain extent, takes place almost instantly after the trunk has been tied. I observed this in a child in whom I had secured the carotid artery. I could see the branches of the temporal and occipital underneath the delicate integument enlarging, and thus actively acquiring great additional vigour immediately after the operation.' (*On Aneurism*, p. 12.) As to the time at which the process is completed, the following is extracted from Porta, op. cit. p. 223: 'It is difficult to determine the time of the restoration of the collateral circulation after the ligature, inasmuch as it varies in different cases. Sometimes, after two or three months, the anastomotic circulation is so full, that it seems at the height of its development; while in other cases, six or eight months afterwards (always compared with the healthy limb) it may be said to be hardly matured. From my observations, I am led to believe that the collateral circulation is developed in a limb operated on in the space of a few months, and generally before the end of the first year; because, on analysing specimens at remoter epochs, after 12, 18, 24, 36 months, it is not found that the anastomotic system has progressed farther. This system is fully constituted at that time when it has attained the aim of its development, and has brought up the circulation to the measure of the requirements of the limb, and so is brought to a standstill.'

restored. Thus, if one large branch join the artery below the ligature, the anastomosis being very likely effected principally by a single arch of artery joining this (as in Sir A. Cooper's case), pulsation will be restored quickly; if a large network of small branches carry on the circulation, it may be absent for an indefinite period. Whatever the period may be, it is certain that in a few days at the latest, either gangrene will set in, or the circulation will be so far re-established that the blood will flow through the artery, entering it by the branch which joins it below the ligature, and probably by many of the successive branches. Thus, when the ligature has been applied far away from the disease, the blood returns into the vessel above the aneurism; and so, if the tumour be not already filled with clot, the circulation through it may be re-established. This circulation is sometimes sufficient to prevent coagulation and to perpetuate the disease; and failures from this cause are occasionally, but rarely, noted. More commonly, the force of the circulation is sufficient to cause a sort of undulatory movement to become perceptible in the contents of the tumour a few days after the ligature; but coagulation is advancing, and will rapidly suppress this movement, which soon ceases to be appreciable. Now in these successful cases the anatomical condition of parts may be twofold. If the artery and aneurism form one channel, or if the aneurism stand off like a bud from the artery, the canal of the vessel may be left pervious,* and the circulation will be carried on through it. But in the great majority of aneurisms, which are neither fusiform nor pedunculated, but sessile, and involving more or less of the circumference of the vessel, the obliteration of the tumour involves that of the affected artery; and now another arch of anastomosis will often be required. The necessity for the formation of this lower arch of anastomosis will depend on the distance

* The latter disposition of parts existed in a case where Sir A. Cooper tied the external iliac. See the account of the dissection in *Guy's Hospital Reports*, vol. i. I have not met with a case of the former disposition after ligature; but it may be seen after spontaneous cure in Hodgson's case, quoted on p. 444; and after the cure by pressure in a preparation in St. George's Hospital Museum, figured on p. 494. In the first case of ligature of the internal iliac, by Dr. Stevens, the pelvis was brought over to this country for dissection, the patient having survived the operation ten years. The account (by Prof. Owen) of the dissection may be found in *Med.-Chir. Trans.* vol. xvi., and there it is noticed that the aneurism (which was of the tubular kind) had in the centre a cavity containing only loose coagula; but no circulation had gone on through it.

between the point of ligature and the aneurism, and on the number of branches which communicate with the main trunk between them. If the point of ligature be distant, as in the common operation for popliteal aneurism, or if many branches intervene, the artery will be pervious between the ligature and the tumour (Fig. 160), and therefore two sets of collaterals must be developed; one to carry the blood round the seat of ligature, the other round the aneurism. There is no evidence to prove that this double call upon the powers of nature exercises an unfavourable influence on the prospects of the operation, although it is quite possible that it may do so. Thus, some of the cases of suppuration in the sac after ligature, such as those quoted on pp. 447, 448, may be due to imperfect development of collaterals round the aneurism, and the consequent persistence of the circulation through the tumour, which ought to be temporary only. It is probable, however, that the very fact of the existence of an aneurism exerts in most cases a retarding influence on the circulation through the trunk of the vessel, and thus induces a preliminary expansion of the branches immediately above it, so that the lower arch of anastomosis may be more easily formed than the upper; or the latter may take the place of both, the collaterals above the ligature communicating with the branches of the artery beyond the aneurism, as would be the case in an aneurism seated on the common carotid, where no branches intervene between the ligature and the tumour, and usually in the external iliac. In most cases, dissection after a successful operation will show the artery obliterated at the seat of ligature and at that of the aneurism, and pervious between them.*

The immediate effect of a ligature applied to a main trunk is of course to suspend for the time the supply of blood and the vis a tergo of the heart. Hence congestion of the blood in the extremity, and hence temporary rise of temperature.† Another

* For a collection of several cases in which the femoral artery was found pervious between the ligature and the aneurism, see Wishart's *Scarpa*, pp. 263-4.

† See Dr. J. R. Wood's case, in 'Report of Surgical Practice of Belle Vue Hospital,' *N. Y. Journ. of Med.* 1858, p. 239; and Sir. W. Lawrence's, in *Med.-Chir. Trans.* vol. vi. p. 206. It will be remarked in the latter case, one of ligature of the external iliac, that though the ham on the affected side was warmer than on the sound side, the foot was always colder. It is interesting to observe that in experiments on animals this rise of temperature does not take place, the activity of the collateral circulation preventing even temporary congestion (see Broca, p. 507).

immediate and necessary effect of the ligature is the temporary loss of power in the parts supplied by the obliterated artery. This phenomenon is not so often observed in men, since the conditions of their treatment prevent any attempt at movement of the limb operated on;* hence a tingling and numbness is generally all that is complained of; but it can easily be verified on animals. Thus, after ligature of the abdominal aorta in a dog, the animal will be noticed to drag his hind legs just as if he had received a severe injury to the spine. Sometimes in men, although the immediate paralysis may pass unobserved, its effects will persist, and a partial loss of motion in the limb will be permanent. Still more often the nutrition of the part is impaired, so that the member is thinner, colder, and weaker than the other. This I have myself noticed in the case of the child above referred to, in whom the axillary artery had been tied. When she was last seen (more than a year after the operation), the arm, although it was the right, was decidedly smaller and weaker than the other. Thus also gangrene, from accidental exposure to cold, may occur long afterwards in the toes in cases where the femoral artery has been tied, even when no symptom of gangrene has followed immediately on the operation.† These unfavourable consequences should not be lost sight of in determining the question of ligature or compression. They depend in all probability on a defective development, either in size or number, of the collaterals, by which the nutrition of the parts is diminished, the conducting property of the nerves probably suspended, and the irritability of the muscles impaired. Mr. Liston thought that the excessive development of anastomosing branches running in the substance of nerves, such as the *comes nervi ischiatici*, might produce paralysis. This seems improbable, but receives a certain amount of support from a case

* But sometimes slight and transient paralysis of motion or sensation is observed (see Mr. Chamberlaine's case of ligature of the axillary artery, *Med.-Chir Trans.* vol. vi. p. 131).

† A kind of semi-gangrene is often found in limbs where the main artery has been tied, leading to a low and obstinate form of ulceration. A patient was lately under my care, in whom the femoral artery had been tied in the groin, by Mr. Smyly. Two of the toes had mortified, but the sore had healed, and this would have given him no inconvenience. The whole foot and leg, however, was cold and weak, and the skin prone to a very obstinate ulceration, which rendered it difficult for him to earn his living. I ought to say, however, that he had suffered before the operation from some disease of the skin.

related by Porta, and from some observations which he has made upon it.*

Causes of death after ligature.—The chief dangers following the operation are from gangrene and secondary hæmorrhage,†

* See Porta, op. cit. p. 381.

† In the *American Journal of Medical Science*, new series, vols. x. xiii. xiv. xviii. xl. are some excellent statistical papers upon the ligature of the principal arteries, viz. the subclavian, carotid, femoral, external, internal, and common iliac, showing the proportion and causes of death in each operation. The former papers are from the pen of Dr. Norris; the last is by Dr. Stephen Smith. As they display an amount of mortality after these operations which is probably not generally known, it may be as well to quote all these statistics together.

Ligature of	No. of cases collected.	No. of deaths	Per cent.
Subclavian	69 . . .	33 . . .	47·8
Carotid	149 . . .	54 . . .	36·2
Femoral	204 . . .	50 . . .	24·5
External iliac . . .	118 . . .	33 . . .	27·9
Internal iliac . . .	7 . . .	3 . . .	42·8
Common iliac . . .	32 . . .	25 . . .	78·1
Total	579 . . .	198 . . .	33·1

Dr. Pilz's and Dr. Cutter's more recent and fuller statistics of the ligature of the carotid and external iliac arteries, which will be referred to hereafter, raise the mortality after those operations still higher.

If the reader will compare these returns with the most complete statistics hitherto obtained of the mortality after other surgical operations, as those of amputation by Mr. Bryant in *Med.-Chir Trans.* vol. xlii., he will at once see that the ligature of the main artery of a limb involves the gravest dangers, and is an operation which should only be undertaken in the face of evident necessity. The above returns might have been made still more unfavourable by collecting the cases of ligature of the two largest arteries—the aorta and innominate; but it was thought better not to include operations which many persons consider unjustifiable, and which will probably be soon banished from surgical practice.

By comparing Mr. Bryant's statistics of amputation, it will be seen that the ligature even of the femoral artery, the lowest in this list, is almost as fatal as ordinary amputation of the thigh (which appears in those statistics as being fatal in 27·27 per cent. of cases), while most of the others approach the mortality of the greater primary amputations.

These considerations show strongly the propriety of avoiding ligature of a large artery whenever there is any prospect of curing the disease by any other method. The table in Porta's work (p. 404) gives a similar conclusion. It contains a synopsis of 600 cases, and might perhaps have been expected to be somewhat more favourable than the above statistics; as, although it includes 12 cases of ligature of the aorta and innominate (which were uniformly fatal),

excluding the complications to which all operations are exposed, and the special dangers which result in tying individual arteries from their anatomical relations, and which will be discussed in speaking of the special operations. Gangrene is perhaps a more frequent cause of death than hæmorrhage after ligature of arteries in the lower extremity.* In the upper extremity, the anastomoses are so frequent, that the parts are nearly in the same conditions as in the lower animals, in whom gangrene is, as we have seen, unknown. The causes of gangrene are, a deficiency in number or in extensibility of the collateral branches, or a want of due care in maintaining the temperature of the part after the operation, constricting the limb with bandages, or, finally, some injury done to the principal vein of the limb during the operation.† Little can be

it also comprises 68 of ligature of the brachial, an operation which is generally successful. Still the deaths are 167, or more than 27 per cent. ; nor does it show a much more favourable average in any operations except the ligature of the subclavian and common carotid. The difference, however, between Porta's statistics of these operations and those of Norris depends, I have no doubt, merely on some of the published fatal cases having escaped Porta's investigation. The real averages are probably more unfavourable ; fatal cases having remained unpublished. At least this conclusion is supported both by what we know of the nature of published cases, and by the experience of English surgeons in the ligature of arteries, as shown in the statistics of the *Medical Times and Gazette*, which will be again referred to.

* Of the fifty fatal cases of ligature of the femoral artery in Norris's table, twenty-three are stated to have died of gangrene and only eight of hæmorrhage.

† That gangrene is often due to injury of the vein is an opinion which Mr. Syme has strongly insisted on (*Principles of Surgery*, 1856, p. 99). He even appears to go so far as to allege this as the only cause of gangrene, discrediting the received opinion (which has just been stated above) entirely. But that gangrene may occur when no injury has been done to the vein is proved by numerous facts. Amongst others, a preparation exists in the Museum of St. George's Hospital, with a record of a careful dissection by the late Mr. Gray, in which the vein was clearly proved to be perfectly healthy and uninjured, yet the patient died of gangrene. The vein has also been known to be included in many operations on the femoral artery without any symptom of gangrene. John Hunter at first purposely tied up the vein, and Roux has confessed to having done so accidentally. Langenbeck (*Archiv für kl. Chir.* vol. i. pt. 1) and Gibson (*Am. Journ. of Med. Sc.* vol. xiii. p. 305) have both tied the internal jugular vein and carotid artery in extirpating tumours, Cooper of San Francisco (*New York Journ. of Med.* 1857, vol. iii. ser. iii. p. 410) the external iliac vein and artery in a case of aneurism, with good results. The *partial* ligature of the vein, in which the thread is left like a seton in the cavity of the vessel, is much more likely to be followed by fatal effects. Mr.

done to obviate the first cause of failure. It may be suspected, in persons of weak circulation and exhausted by old age or excess, that in the former case their arteries may possibly not anastomose very freely, while the latter class are nearly sure to labour under an atheromatous condition of the vessels. Hence both are bad subjects for the ligature of an important artery; but as these operations are now never performed unless under circumstances of urgency, in which all risks must be run, a knowledge of the state of the arteries, even if it could be certainly attained, would, after all, only affect prognosis. Much may, however, be done to prevent gangrene by maintaining the temperature of the part. It would seem at first sight inconsistent to talk of the necessity of keeping up the temperature in an extremity in which, as we have seen, it has already risen above the standard of health. But this contradiction is only apparent. The temperature of the toes rises after ligature of the femoral artery, not from increased power in the part, or increased vital activity, in which case it would clearly be wrong to add fuel to the fire, but from diminution of the vis a tergo of the heart, and consequent stagnation of the blood in the extreme vessels. Expose the part to cold—the tissues will contract upon and unload the vessels, which will themselves also be constricted by the cold—and the part will not only be deprived of blood, but a powerful obstacle will be offered to the weakened circulation by the rigid and contracted state of the vessels and the parts which support them; an obstacle which most probably will be found insurmountable. Hence the importance of maintaining the limb as near the natural temperature of the body as possible. It should not be much warmer, since parts in which the circulation is imperfect are as little able to resist heat as cold: thus gangrene has followed the application of hot salt or sand-bags to the limb. The best application is carded wool, which merely retains the natural warmth, and has the additional merit of retaining it without requiring renewal, while it allows the occasional inspection of the limb if required. It is advisable, however, to make such inspection only rarely, since it cannot be done without some change of temperature, which, if often repeated, might have a

Carmichael and others have spoken of the occurrence of phlebitis and obliteration of the vein, sometimes followed by gangrene, as a consequence of injury to the vein (see Broca, p. 479).

prejudicial effect. The wool should be used in large quantity, so as to form a thick layer around the whole limb, nearly as high as the seat of operation, and secured by a bandage loosely twisted round. It will be understood that the limb should be kept in such a position as to facilitate the return of blood.*

The patient's diet and regimen should not be too rigid. This will of course be regulated by his previous habits; and the same may be said of the exhibition of opium. In persons of dissipated lives and nervous temperaments, stimulants and moderate quantities of opium must be allowed; while robust persons, with equable and tolerably strong pulse (who, however, are rarely the subjects of aneurism), will do better on a nourishing but unstimulating diet.

When gangrene has once declared itself, which usually occurs on the second to the fourth day,† the case becomes grave; but the prognosis is not hopeless.‡ All depends on the rapidity with which the mortification advances. If, as is sometimes the case, it shows itself, not merely in the ends of the toes, but simultaneously on the dorsum of the foot, and advances with rapidity, no time should be lost in amputating, and the limb should be removed as near the seat of ligature as may be found convenient. It is not absolutely necessary to operate at, or above, the place where the artery has been tied. The portion of the limb just below this spot is nourished, not from the obliterated part of the vessel, but by the branches of a higher origin, so that there is no fear of sloughing of the stump.

When the gangrene, on the contrary, appears only in a limited space, and extends slowly in the continuity of the limb, hope may rationally be entertained of preserving the member. The case must be treated like any other case of gangrene, by local warmth, local and general stimulants, and opium, with due regard to the patient's constitution, nervous temperament, and general symptoms. I venture to think that the attempt to preserve limbs after gangrene the result of ligature is not,

* Mr. Guthrie's favourite method for obviating gangrene was to have the limb constantly chafed by the attendants.

† Although sometimes not till the second or third week (Porta, *op. cit.* p. 393). In Dr. Hargrave's case of ligature of the common iliac artery (Dublin, 1865), gangrene did not show itself till the thirty-first day, and was hardly stopped when the patient died on the seventy-third day.

‡ The mortality of gangrene after ligature of the femoral artery is estimated by Porta at 71 per cent.

generally speaking, carried far enough. The prognosis of amputation in these circumstances is not very favourable; the cases closely resembling those of secondary amputation—the most fatal, according to Mr. Bryant,* of all classes of amputation.† Suppuration and sloughing of the sac is a kind of gangrene, and is one of the chief causes of death after ligature. It sometimes gives rise to hæmorrhage; but more frequently it poisons the blood, and leads to death either by pyæmia, or by that systemic infection of which pyæmia is the local manifestation.

The other cause of death, that from secondary hæmorrhage, has been already treated of in the essay on INJURIES OF THE VESSELS, vol. i. p. 738.‡ It is more common in the upper extremity, where the heart is near, the circulation powerful, and the processes more rapid, than in the lower. It is also more to be apprehended after ligature for aneurism, when the artery is more likely to be diseased at the point operated on, than for wound, when it will, in all probability, be healthy.

Besides these causes of death after ligature, the operation sometimes fails to cure the aneurism, though the patient survives. This, indeed, is rare; but it seems to occur in two ways. Either the pulsation never disappears in the tumour, and the latter, perhaps after a temporary check, continues growing in size, and will ultimately burst; or the aneurism diminishes, becomes solid, and undergoes a process of apparent cure, but then, after a longer or shorter period of quiescence, the pulsation reappears, sometimes with a sudden increase in size, and the disease is said to recur.

When the ligature fails to abolish the pulsation, this depends again on one of two causes. The artery may have connected with it a ‘vas aberrans,’ by which the blood is brought directly down into the tumour. Such was the state of parts in Sir C. Bell’s case of ligature of the femoral artery.§ This condition of the vessels, however, will not escape the attention of a careful and well-instructed operator; and the fact that tightening the ligature has not its usual effect on the pulsation of the aneurism, will show that the latter must either be seated on some other vessel, or, at any rate, must communicate as freely with another

* *Med.-Chir. Trans.* vol. xlii.

† Of forty-nine cases of gangrene after ligature, fourteen recovered; ten of these without, and only four after, amputation (Porta, op. cit. p. 394).

‡ See also the sections on ligature of individual arteries.

§ *London Medical and Physical Journal*, vol. lvi. p. 134.

vessel as with the one tied. Accordingly this other vessel must be sought for by careful dissection; and until it is found the original ligature is not to be tightened. If there be a vas aberrans, the other vessel will be at no great distance, and should be tied at once. When this has been done, if pulsation is quite abolished in the aneurism, it will perhaps be unnecessary to tie the vessel first exposed; but it will be more prudent to leave the ligature (which has been already passed) under it, to be tied on the first symptom of returning pulsation in the tumour. These anatomical anomalies are so rare as to be merely surgical curiosities; still they should be borne in mind. It more frequently occurs that the circulation through the aneurism, temporarily abolished by the ligature, returns in a few hours or days, and continues to increase till it reaches its previous force, and the disease runs its course apparently unaffected by the operation.* This accident must be due to the preternatural activity of the collateral circulation; and it is one which it is difficult to meet with appropriate treatment. In the first place, it seems reasonable that nothing should be done until the limb appears beyond the risk of gangrene, and until the pulsation is plainly permanent; and this cannot be said to be the case until the tumour has been pulsating very distinctly for some months, and the pulsation shows no tendency to abate.

* The temporary return of pulsation is not so uncommon. Porta remarks on this head: 'Out of 448 cases of aneurism and aneurismal varix cured by the Hunterian operation, there was in twenty-five cases a relapse; that is to say, a manifest reappearance of pulsation in the tumour; but the pulsation was temporary, lasting from a few weeks to some months, and then disappearing. The case, however, above related of Miloni, and the two published cases under the care of Cooper and Roux, show that even in the thigh the anastomosis may enlarge to such a point as to annul the action of the ligature. Such cases are fortunately most rare. Relapse would occur much more frequently in the neck and elbow, where the anastomoses are naturally so ample and direct, were it not that the aneurism, however small, already contains some clot; and the blood, directly on the application of the ligature, being reduced for some days to the minimum of movement in the trunk operated on, ceases during that time to feed the tumour and the aneurismal artery, so allowing the obliteration of both by fresh clot' (op. cit. p. 385). The three cases referred to will be found in Porta, p. 378; *Brit. and For. Med. Rev.* vol. vi. p. 67; *Bolletino di Bologna*, an. xiii. series 2, vol. xi. p. 185. Another case, which illustrates the return of circulation after ligature, occurred in Mr. Stanley's practice. He tied the posterior tibial artery low down in the leg for wound, using two ligatures at some distance from the opening. Hæmorrhage continued; and he had to place other threads closer to the hole in the artery (Ormerod, *Clinical Collections*, p. 151).

It should always be borne in mind that a slight undulatory pulsation in an aneurism on the second or third day after ligature is a very usual phenomenon, and so far from being of evil augury, is considered by many authors to be a favourable sign, rendering it more probable that laminated clot will form. It is assumed that, previous to the original operation, compression of the artery above the tumour has either been tried and failed, or was contra-indicated. Hence it will be probably useless to recur to that method. Direct pressure, or genuflexion or forcible flexion of the elbow, if the aneurism be in the forearm, with appropriate bandaging of the limb, will of course be tried. When these measures fail, two courses are open—either to tie the artery lower down, between the ligature and the aneurism, or to perform the old operation of opening the sac and tying the artery as it enters and leaves it. As a general rule, the former method will be preferable in the lower extremity, the latter in the upper. Or if the surgeon has sufficient confidence in such measures, he may resort to galvano-puncture, or to the injection of perchloride of iron (see below the sections which treat of these methods of curing aneurism). The ligature of the main trunk above the original seat of operation has been tried, but it appears to be contra-indicated both by theory and practice.*

The recurrence of aneurism is, however, usually observed at a later period, after the persistence of the apparent cure for weeks or months. This was the case with a patient of Mr. Spence, of Edinburgh, in whom the aneurism was afterwards cured by genuflexion. The case will be found quoted lower down. It does not appear that the cure was ever a sound one after the ligature; and the pulsation in the aneurism was never abolished, though on the patient's first discharge it had been reduced to a line which was thought not to be more extensive than that of the popliteal on the other side. Cases such as this fail from the faulty formation of the clot. The sac is filled, not with laminated coagulum, but in part, at least, with mere soft clots; and these clots in the course of time soften and yield to the force of the circulation, or pass into its current. When this is the case, the affair becomes even more grave than when the disease recurs from the causes mentioned in the last paragraph,

* As to the three cases mentioned in the previous note:—in Sir Astley Cooper's case the artery was tied close above the sac successfully: in Porta's case the external iliac was tied; but the patient died of the operation: in Roux's case no treatment seems to have been adopted.

since the too rapid development of the collaterals is, after all, rather a phenomenon of over vitality than otherwise ; while, on the contrary, this indisposition of the blood to form laminated coagula under the usual conditions, appears to testify to some profound alteration in the vital fluid itself. The prognosis, therefore, will be worse than in the latter case ; but the treatment must be the same, since no more radical measures are at hand except amputation ; and to this no judicious surgeon will have recourse until he is clearly certain that no other course is open. When, however, the ligature has certainly failed, and the case seems otherwise hopeless, no good can be expected from delaying amputation.

Such are the causes of failure, and the methods, at the best very uncertain of success, by which they may be met. But in the great majority of cases in which the patient survives the operation, matters progress quite otherwise. The ligature, after a certain length of time (which varies, generally between about ten days and a month, according to the size of the vessel, the neatness with which it has been separated from contiguous parts, and the rapidity of vital changes in the patient operated on), cuts through the artery, and comes away with the discharge. The wound then heals, the divided ends of the artery reunite, and the whole of the obliterated portion of the vessel degenerates into a fibrous cord. The tumour, at the same time, consolidates more or less rapidly ; the undulating movement, which was perceptible in it at first, disappearing as the deposition of laminated coagulum advances, until at length the whole is consolidated, and then begins to shrink. Finally, as after the spontaneous cure, a small hard tumour remains, like a walnut, which, if cut into, displays a structure something like that of an onion. With the exception of the obliteration of the artery at these two points (for the persistence of circulation through or past the aneurism is rare), and the consequent development of collaterals, everything in the limb is natural. In other cases, the weakness and the faults of nutrition, which always attend at first upon the ligature of the main trunk of a limb, persist, and occasion atrophy of the muscles, fatty degeneration, &c.

Having discussed the mode of action and the effects of a ligature applied to the main artery of a limb above the sac of an aneurism, as Hunter directed, it is perhaps necessary for me to express an opinion as to the cases in which this plan is indicated. The best formulæ, I think, would be as follows :

1. It is indicated whenever the aneurism (which must always be supposed to be in an active condition, and advancing, or threatening to advance) is situated upon an artery inaccessible to pressure, but which will allow a ligature to be put round it without excessive danger, and with a sufficient space between the part tied and the tumour. Of these conditions the iliac and carotid arteries furnish the best examples.

2. When in an aneurism differently situated, the patient, from nervous irritability, drunkenness, or any other cause, is intolerant of more gradual methods, such as pressure, genuflexion, &c.*

3. When these methods have been tried and failed.

4. When an aneurism has burst into one of the internal cavities of the body, *e.g.* a popliteal aneurism into the knee-joint.

For a very interesting example of cure by ligature of the femoral, even after this formidable complication, the reader is referred to a case which occurred at the Middlesex Hospital, under the care of Mr. Moore, and which will be found reported in the *British Medical Journal*, 1859, p. 489.

5. When the rupture has taken place subcutaneously, amputation or the ligature is generally indicated; still, in some of the less grave cases, it may be possible to obtain a cure by compression, but the attempt should not be too long persisted in; while, if the symptoms are urgent, or if gangrene have commenced, amputation is the only resource.†

Internal aneurism does not absolutely contra-indicate the operation, although it is a most powerful motive for avoiding it unless it is believed necessary for the immediate preservation of

* Such intolerance must not, however, be too hastily admitted. Almost every person of ordinary good sense, and even of less than ordinary resolution, may be educated, by the gradual and transient use of digital pressure first, and the pressure of instruments afterwards, to bear the amount and duration of compression which is requisite.

† The subject of rupture of aneurism has been referred to above (p. 427). A paper by Samuel Cooper in *Med.-Chir. Trans.* vol. xvi., will repay perusal. He points out that the pain is not always severe, that the shape of the tumour may be not much altered, and that, beyond a little purple discoloration, no trace of ecchymosis may be noticed. In these cases he is inclined to lay great stress upon the persistence of bruit, combined with the absence or gradual disappearance of pulsation, and a sudden fall in the temperature of the limb. Mr. Poland's paper, in *Guy's Hospital Reports*, 3rd series, vol. vi., contains notes of 42 cases in which the sac of a popliteal aneurism burst, and of the result of the treatment. In 2 no treatment was adopted: in 1 of these the tumour burst externally, but the patient survived the bleeding and recovered. In 24 compression was used; which succeeded in 2 cases. In 16 the femoral artery was tied: 10 recovered without, and 2 after, amputation; 4 died—3 of gangrene, 1 after amputation on account of suppuration of the sac.

life. Dr. Crisp (op. cit. p. 189) says that several cases are recorded where persons with aneurism of the thoracic aorta have survived the operation. But, in one celebrated case, the patient died on the table, from rupture of an internal aneurism, just as the operation was being begun. This accident would now probably have been avoided by the quietness and absence of agitation produced by anæsthesia.

Contra-indications to ligature.—The late Mr. Aston Key has declared that, in his opinion, ‘the only circumstance that ought to deter a surgeon from putting a ligature around any artery in the human body (not excepting the aorta) is, the uniform cessation of circulation in the parts below the ligature.’* But if we regard the preservation of the patient’s life as the ultimate end of all operations, we must surely allow that any proceeding which is uniformly followed by death is unjustifiable, by whatever cause or causes death may have been produced; and, still more clearly so, if the disease for which the operation has been undertaken has been known to be cured by other means. To both these objections the operations for securing the aorta and innominate artery are fairly liable. On the first head, it may indeed be urged that the number of cases of ligature is as yet insufficient to allow of our asserting that these operations are uniformly fatal. This is a point which must be left to the judgment of those who may be called upon to decide on the treatment of a case of this nature; but on the second head there is no doubt. Aneurisms at the root of the neck and in the belly have often yielded to medical treatment or undergone spontaneous cure, while they have as yet never been cured by operation, except in one instance of traumatic aneurism, for which the innominate was tied. So that, if ligature be used at all in these aneurisms, it should only be as a last resort, when they have burst or are on the point of bursting, or when they are increasing under the best medical treatment which can be procured.† Again, the ligature should never be applied to any artery which is so situated as to admit of compression, unless

* *Med.-Chir. Trans.* vol. xiii. p. 8.

† In such a case as the one in which Sir A. Cooper tied the aorta, viz. when the aneurism had opened externally, we may allow that the operation was the only conceivable means of giving the patient a chance for his life, and was equally creditable to the boldness and dexterity of the surgeon. If it be objected that the rules laid down in the text would prevent operations in the root of the neck altogether, since, unless the artery is tied early, it will be out of reach—I would reply, that this argument would show the ligature of the innominate to be an unjustifiable proceeding; for in an early stage of aneurism

that treatment has been tried and failed, or is contra-indicated by some peculiarity in the case. Nor should the ligature be used in cases of recent traumatic aneurism, particularly when caused by fracture, without a previous trial of the resources of nature, aided by such means as rest, position, careful bandaging, and pressure direct and indirect. Such cases, as we shall see, are peculiarly likely to undergo spontaneous cure. Nor should the ligature be used if the heart or a great part of the arterial system is diseased. In such cases digital compression is the most appropriate and safest treatment.

ACUPRESSURE AND TEMPORARY LIGATURE.

This seems the most appropriate place to notice the proposals which have been made to treat aneurism by the temporary application of compression to the trunk of the vessel affected. These proposals, it is true, have not hitherto come to much; but since Sir J. Simpson's suggestion of acupressure has been so generally adopted, compression of the trunk in this way has occasionally been successful, and this has led to a revival in other forms of the temporary ligature, which proved unsuccessful in the hands of Scarpa, Clive, Sir P. Crampton, and the other surgeons mentioned by Mr. South (*Trans. of Chelius' System of Surgery*, vol. ii. pp. 218, 222).

A successful instance of the application of acupressure to the cure of a small traumatic aneurism in the ham (probably formed on one of the sural arteries) is referred to by Mr. H. Lee, in the *St. George's Hospital Reports*, vol. iii. p. 33. Dr. Cheevers has recorded in the *Boston Med. Journ.* Oct. 17, 1867, a case in which he applied acupressure successfully to the femoral artery in popliteal aneurism; but the case was not cured in any shorter time than it would have been by ligature, and the patient seems to have run just as much risk—the artery having been freely exposed, and apparently somewhat roughly handled.

Prof. Porter treated a case of subclavian aneurism unsuccessfully by acupressure of the axillary on the distal side of the tumour. The man died not very long afterwards, and the vessel was found not completely occluded, but narrowed. —*Dublin Quarterly Journal*, Nov. 1867.

Numerous contrivances for the temporary occlusion of divided or exposed arteries have been introduced.

One of the neatest appears to be that recommended by Dr. G. H. Porter,* which

at the root of the neck, the patient has some chance of spontaneous cure, and a good chance of surviving a tolerably long period, while after the operation his life will, in all probability, be reckoned by hours.

* *Dublin Quarterly Journal*, 1868. This instrument was used for temporary deligation of the abdominal aorta by Dr. W. Stokes, jun. See the same *Journal* for Aug. 1869.

bears some resemblance to an instrument devised by Sir P. Crampton and described in the passage of South's *Chelius*, above referred to, except that the agent of compression is silver wire. This is passed under the artery with an aneurism-needle, and is attached to a small frame made of bent wire, and provided with a ring. The wire is drawn through the ring tight enough to stop the circulation, and is then fixed by twisting it round the ring. When the desired effect has been produced, it can be at once removed.*

Further experience, however, is necessary to show whether these plans have any real superiority over the ligature used in the ordinary way.

Brasdor's operation will be discussed along with the treatment of aneurism in the neck, where it is chiefly, if not solely, employed.

TREATMENT BY INSTRUMENTAL COMPRESSION.

The treatment of aneurism by compression is a practice of almost as old a date as that by ligature;† but, like it, had fallen out of use from certain imperfections in its details, until it was taken up again, improved, and fitted for practical use by modern surgeons. The old treatment consisted in the application of continuous pressure either to the sac, to the artery above it, or to both; and the cause of its frequent failure, or rather of the great rarity of its success in the hands of the ancient surgeons, arose from their ignorance of the natural process, as we have above attempted to describe it, which effects the cure of aneurisms. Not being aware that the deposition of laminated clot, when once begun, would go on, under favourable circumstances, to the entire obliteration of the sac in almost every case, and that, for the commencement of that coagulation, only a moderate check to the circulation would suffice, they always aimed at suppressing the circulation through the aneurism altogether,‡

* For other methods of making temporary compression on exposed arteries, see the authorities quoted in the *Biennial Retrospect of the New Syd. Soc.* 1867-8, p. 214.

† Heister is said to have been the earliest author who recommended pressure in the cure of aneurism, and Guattani the first surgeon who used it with success; but this was direct pressure. See Bellingham, *On Aneurism*.

‡ It may be interesting to recall Hunter's case: 'The aneurism was in the femoral artery, and the swelling appeared upon the anterior part of the thigh, a little above the middle, extending upwards nearly to Poupart's ligament. An attempt was made, by compressing the artery above the tumour by means of an instrument somewhat resembling a steel truss, to give the blood in the sac a chance of coagulating, and by that means put a stop to the progress of the disease. But, from the pain which it occasioned, every attempt to make a permanent compression on the artery proved ineffectual.' He then proceeds to

and if possible bringing the sides of the sac into contact. It was therefore necessary, in their opinion, to use such an amount of pressure as could hardly be tolerated by any one of ordinary sensitiveness, and which, even if borne by the patient, was pretty sure to produce sloughing. It was from a similar ignorance of the curative powers of nature, and of the ease with which the nice balance between the force of the circulation and the reaction of the arterial walls may be restored, that the Hunterian operation, which had been recommended by the Greek and Arabian writers (whether practised or not, is another question), fell out of notice till that great surgeon re-invented it. Thus, in reading accounts of Guattani's cases, and of others in which the old surgeons attempted to cure aneurism by compression, we are at once struck by the fact, that the pressure was always either too severe or applied to the wrong part, and often both. For as they thought that the principal point was to exclude the blood from the sac, of course the chief means of doing so was to empty the sac by direct pressure. When this was impossible, the next thing was to compress the artery above so firmly that no blood could pass. The modern system of gradual and partial compression,* is entirely different in principle, and is a strict imitation of the process of spontaneous cure. We have seen that when an aneurism is cured spontaneously, it is in consequence of the circulation having received some partial check, by which laminated coagulum is deposited within the sac. Just so in the cure of aneurism by this method of compression. It is merely necessary to lessen the force of the circulation through the aneurism during some considerable part of each day, and then usually in a few days, but sometimes not till the end of several weeks, it will be noticed that the oedema and venous congestion have quickly subsided, and that pulsation is diminishing in the tumour, that its contents are more solid (which may be known by its varying less in size according as the blood is shut off or let in from the artery when the finger is pressed

describe the progress of the case, the aneurism undergoing a spontaneous cure. (Hunter's *Works*, vol. iii. p. 602.) The pressure appears to have been applied too strongly, too constantly, and too much in one place. Yet Hunter was fully aware that the cure of aneurism was quite compatible with the persistence of circulation. Much more would surgeons who thought it necessary altogether to abolish the circulation fall into such errors.

* The other and still more modern method of total compression during a few hours under chloroform will be spoken of afterwards. It was of course impracticable before the introduction of anæsthetics.

on it), and that the anastomosing branches are increasing so as to be felt pulsating. When these signs are present, we may be pretty sure that the cure of the aneurism is not far distant.

It would be wrong to pass over in silence the history of this method, although the length to which this essay necessarily extends prevents me from saying more than a very few words on the part played by the Irish surgeons in introducing the treatment of aneurism by compression, and on the gratifying success which has attended that treatment.

It has been noticed above that Hunter treated a case of femoral aneurism by compression on the artery between the tumour and the heart (indirect pressure); and the same plan was adopted by Sir W. Blizard,* and is strongly advocated by Mr. Freer;† but the latter surgeon, and probably all who preceded those of the Irish school, unless Hunter be an exception, thought that pressure was to act by obliterating the artery. The pain was very great, in consequence of the assumed necessity of making very firm pressure always in the same spot; nevertheless, some few cures were obtained under the care of Pelletan (or Echard), Dubois, Dupuytren, Boyer, and Albers, and are quoted in Dr. Bellingham's work; but these cases of success were balanced by failures, which, according to Dr. Bellingham, were 'still more numerous;' and the treatment was so painful and so uncertain, that it seemed likely to fall into complete discredit, until Mr. Todd of Dublin recommended the use of the plan as an adjuvant to the Hunterian operation; his object being, by preliminary pressure on the trunk of the femoral, to cause the dilatation of the collateral branches, and so to lessen the risk of gangrene. For this purpose he made use of the instrument originally invented by Heister; but no striking results followed from this practice,‡ which was adopted by some surgeons in Dublin and decried by others, but regarded by all merely as an accessory to the ligature, until the accidental success of pressure applied in the case of a patient of Dr. Hutton's (Oct. 3, 1842), who refused to submit to the operation, shortly followed by similar success on a patient of Mr. Cusack's, whose health appeared too broken to enable him to survive the ligature, led to a better appreciation of the matter; and the striking success obtained in a patient of Dr. Bellingham's, the aneurism being cured in two days, drew the attention of surgeons in other countries to the matter, and successful cases followed, not only at Dublin, but also at University College Hospital under Mr. Liston's care, and in other parts of the kingdom. Still the great majority of the cases were treated in Ireland; and it is to the Irish surgeons, and especially to Dr. Bellingham, that the profession is indebted for the true theory of this method of cure. Their success in the application of the treatment has also been much greater than has been obtained in London. In Dr. Bellingham's small but very valuable work on Aneurism§ (from which the above particulars are

* Bellingham, op. cit. p. 28.

† *On Aneurism*, pp. 94 et sqq.

‡ It is said, however, to have effected a cure in one unpublished case. (Tufnell, *On the Treatment of Aneurism by Compression*, p. 27.)

§ *Observations on Aneurism and its Treatment by Compression*. Dublin, 1847. I exclude two cases in which galvanism was also used, and one of which proved fatal.

extracted) may be found short notes of twenty-five cases (most of them treated in Ireland), in which compression was used, and which included all that had been reported up to that date. In only one of these was it found necessary to resort to ligature of the artery, and then not on account of the failure of the method, but in obedience to the wishes of the patient, who seems to have got tired of the treatment, though it appeared on the point of succeeding. (See also Tufnell's work.)

The experience of English surgeons has been far less favourable. In the *Medical Times*, vol. ii. 1856, and vol. i. 1860, are to be found some valuable statistics of the cases which have been under treatment during late years in the metropolitan and provincial hospitals. Of the seventy cases included in the first report, which is believed by the reporter, Mr. Hutchinson, to be statistically accurate, as containing all the cases which had been under treatment, forty-six were popliteal aneurism, treated by pressure. The treatment succeeded in twenty-four of them. Of the remaining twenty-two, in whom the femoral artery was tied, two only died of gangrene; while of ten cases in which the artery was tied without preliminary compression, three died of gangrene. The period of treatment in the successful cases varied from sixty hours to eight months, nineteen days being the average time. The large proportion of cases in which pressure failed will strike the reader. It is probable that it was due to the novelty of the method; since in the second report, which contains fifty-nine cases, treated either by ligature or compression, the latter plan succeeded in twenty-five cases out of thirty-nine. Even this, however, shows a far less striking success than was at first augured for the method, and might have been expected from the experience of Irish surgeons. It is possible that a greater proportion of cures may be obtained as surgeons become more acquainted with the method, and more alive to the necessity of attending to its minuter details. Meanwhile we may agree with Mr. Hutchinson's remark upon the above report, that all the success obtained by compression is clear and unbalanced gain; that in the cases which succeed, the patient is, with no appreciable danger to his life, withdrawn from the very serious risk of the Hunterian operation, and in most of those that fail the dangers of that operation are diminished.

The instruments required for the compression treatment are, one or two compressors, and a weight encased in leather. I shall describe the method as applied to the cure of popliteal aneurism; if the brachial or subclavian were the subject of compression, the modifications would be easily made. The compressors now in use are made on the principle of exerting pressure upon a small space, without any circular constriction of the limb. They consist of a plate or trough, which is applied to the lower surface of the thigh at the point opposite to the artery, and a pad supported on this plate by a strong lever, or arm, and movable in all directions. The lever stands well away from the thigh, and the instrument is kept in position by the compression which it exercises. When applied, it is screwed down upon the artery until the sensation communicated by the

aneurism to the hand is considerably lessened, say diminished about one-half; and is left so until the patient is sensible of inconvenience from it. It is by no means necessary to stop pulsation in the sac altogether, nay, it is not clear that this expedites the cure, unless it can be maintained long enough to cure the disease at once—but for this purpose prolonged anæsthesia is usually required. Patients of quiet temperament and rather blunt sensibility can often tolerate for a time the degree of pressure necessary to stop the circulation; but it will generally be found that even in them it produces injurious consequences, either because the pressure acts on the vein as well as the artery and so causes œdema of the foot, or because the nerves become involved, or perhaps because the sac (which of course shrinks when most of the blood has passed out of it) becomes too violently distended on the withdrawal of the pressure, and so the process of coagulation is interrupted. It is better, then, to commence with very mild pressure, to change the place of its application frequently, and to give the patient such intervals of complete repose as may refresh his spirits and procure him good sleep. The management of the compressor should be intrusted to some one who knows the course of the artery, and can judge of the direction in which pressure should be applied so as to command it. The course of the artery can be indicated by a line drawn down the limb with caustic, and any intelligent patient or nurse soon learns where to apply the pad; but the application of pressure in the right direction is more difficult.* When the patient has got tired of the sensation caused by the pad of the compressor, he can lay the weight upon the femoral artery in the

* Want of space forbids a complete account of the various kinds of compressors which have been invented for the treatment of popliteal and other forms of aneurism. Perhaps the best form, as obtaining the requisite degree of pressure with the least danger of producing a slough, and being, at the same time, least liable to slip, is Dr. Carte's apparatus, in which the arm carrying the pad is attached to the lever by means of india-rubber bands, and is movable in all directions on a ball-and-socket joint. It is very desirable, however, to have several instruments at hand, and to vary the point of pressure. The weight in the groin may be suspended by means of a string or wire, so as just to produce the necessary pressure without fatiguing the patient by holding it in his hand. Mr. Hart has contrived a plan by which the exact amount of pressure exercised is registered upon the compressor. This may be useful in preventing an excess of force from being unadvisedly employed. Much valuable information on these and other points connected with instrumental compression will be found in Tufnell's work on the subject. See also the essay on SURGICAL INSTRUMENTS.

groin, raising it for a few minutes occasionally; or very often the patient prefers stopping the pulse by the pressure of the finger, thus combining digital with instrumental compression.

The general treatment during compression is a point on which some variety of opinion exists. Some surgeons, even in the present day, when stimulation is so much in vogue, prefer to adopt the depleting plan, although not to the extent recommended and practised by Valsalva; but the majority consider that the advantages, if any, derivable from this course, do not equal the difficulties which the restlessness, discomfort, and distress it occasions to the patient, throw in the way of the treatment. I have seen the depleting plan tried once, but it seemed quite inefficient, and the case was the most protracted cure by compression which I ever heard of; while, on the other hand, a sufficient diet with a moderate allowance of stimulants, if the patient has been accustomed to them, appears not to retard the cure, and certainly renders him more disposed to submit to it. Some surgeons, acting on the idea thrown out by Dr. Stokes (see p. 436), prefer to feed the patient on a diet almost exclusively of meat, believing that the blood is thus made richer in fibrine, and more prone to coagulation. Opium is sometimes necessary to procure sleep; but if the patient be not of an irritable disposition, and the pressure has been commenced mildly, he can generally sleep quite well when the instruments are withdrawn; and cases occur occasionally where the patient can sleep undisturbed even while the compressor is applied.

There are two main theories as to the best method of making compression in the cure of aneurism. The one adopted by the Dublin surgeons, as above referred to, is, that a slow current through the sac, is, if not necessary, yet desirable, in order to the deposit of laminated fibrine; and that for this purpose the compression ought not to be applied to the artery tightly enough to stop the circulation. Consequently this plan involves a rather protracted treatment.*

* The time required for the success of the treatment by gradual compression varies remarkably. In 26 successful cases, reported in the *Medical Times and Gazette*, the time varied from 60 hours to 8 months, the average being 19 days. In some of the protracted cases, the cause of delay has been the inefficient way in which the treatment has been carried out. Thus in the case of a young woman who was under Mr. Prescott Hewett's care in St. George's Hospital, on account of popliteal aneurism, some years ago, the disease remained stationary, notwithstanding the constant application of pressure for months, but was cured in a few days after her transference to the care of a different

The other theory is, that if the blood can be completely arrested in the sac by compression stopping the circulation absolutely for some hours, the soft coagulum which is at first formed will gradually go on to complete induration and lamination, and the cure will be thus effected much more speedily and much more surely. Experience is yet needed to show whether the slow or the rapid compression, *i.e.* the partial arrest of the circulation for a considerable time, or its total suppression for a shorter period, is on the whole the best treatment, but plenty of facts exist to prove that aneurism may be cured in both ways. The total suppression of the current in the aneurism is best accomplished by making pressure below as well as above the aneurism; and in ordinary cases the pressure can only be borne by keeping the patient more or less fully under the influence of chloroform. Numerous cases are now on record in which the patient has been kept for many hours under chloroform and a cure has been effected.* In most cases it is true that digital compression, with intermissions, or partial instrumental compression, have been previously employed; but this has not been always the case.

The cases to which the method by total compression are most applicable are those of aneurism in the abdomen, where digital pressure is impracticable, and instrumental compression so painful that the patient must be narcotised in order to tolerate it. It may be employed, however, in any aneurism; and in popliteal aneurism might perhaps be tolerated without chloroform. Here, however, the milder methods have been so successful that I should not myself be disposed to recommend it under ordinary circumstances.

nurse. It was discovered that the previous attendant had been in the habit of allowing her to remove the instrument and walk about the ward. In other cases, however, no such negligence can be detected, yet the cure makes no progress for a considerable time, when a favourable turn suddenly occurs, and the patient recovers rapidly. It seems impossible, with our present knowledge of the processes which go on in aneurismal sacs, to explain the reasons of these uncertainties; but the practical inference is, that as long as the tumour is not increasing, and the patient is not suffering from the treatment, it is reasonable and advisable to persevere.

* See the *Biennial Retrospect of the New Syd. Soc.* for 1865-6, and for 1867-8. The longest period of pressure under chloroform seems to have been 12 hours in a patient under Dr. Mapother's care. By a misprint in the second of the above cited *Retrospects*, it is said that a patient was kept under chloroform for 97 hours—9½ was the time.

Auxiliaries to the treatment by compression may be sought in position of the limb and in direct pressure; but these methods must not be insisted on if they appear to cause distress, and thus endanger the success of the principal agent of treatment.

Signor Ciniselli has written on the use of direct compression in the treatment of aneurism, in the *Annali Universali di Medicina*, 1867, vol. excix. p. 351.* Besides citing several cases in which direct pressure was used as an auxiliary to other means with apparent benefit, he refers to two in which it was the only agent used. One was a case of popliteal aneurism under the care of Bruncker, related in the *Brit. and For. Med.-Chir. Rev.* Jan. 1840, in which pulsation ceased after five days; and the other a traumatic aneurism of the carotid under his own care, in which the pulsation disappeared after ninety-seven days. The agent of compression in both cases, was a large piece of soft sponge firmly bandaged on to the tumour, and wetted once a day to give it the required elasticity.

When compression succeeds, the case is precisely on the same footing anatomically as when the disease undergoes the process of spontaneous cure, so that the reader may be referred to what has been said upon that head in a previous paragraph. Sometimes the artery becomes thickened and contracted where the pressure was applied, and it is possible that it might become obliterated; but changes in the arterial walls are of rare occurrence, and take place probably only when compression has been exercised more vigorously and more continuously upon one spot than is either usual or desirable.† Usually when a limb is examined after the successful use of compression, the artery above the tumour shows no trace of its action (Fig. 161). The tumour is generally quite firm, being filled with laminated coagulum; but sometimes a channel is seen, through which circulation has gone on in it. All this will be seen to be identical with the spontaneous cure. Enlarged anastomosing arteries are generally discovered, and this enlargement is usually and rightly regarded as one of the earliest and best symptoms of commencing cure.

The cure of aneurism by compression does not, however, always involve the obliteration of the sac, and does not, therefore, always involve the establishment of any new circulation. This point is illustrated by a preparation in St. George's

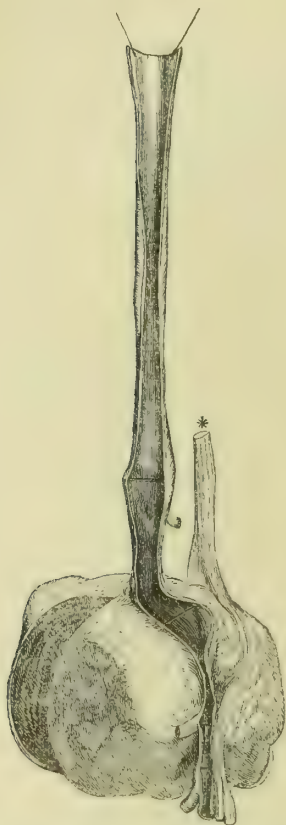
* *New Syd. Soc. Biennial Retrospect* for 1867-8, p. 290.

† In *Med.-Chir. Trans.* vol. xliv. p. 189, will be found a case in which a varicose aneurism formed spontaneously at the part where pressure had been applied to the femoral artery many months before the cure of aneurism.

Hospital Museum (Fig. 162), in which a popliteal aneurism is preserved, which had been treated by compression of the femoral artery for more than two months. The sac lies between the

FIG. 162.

FIG. 161.



Cure of popliteal aneurism by pressure.

The artery remains pervious. The sac is seen to be filled with laminated coagulum. The asterisk points to the nerve spreading over the tumour. (From a preparation in the Museum of St. George's Hospital. Series vi. No. 121.)



The femoral and popliteal artery, from a patient who died about eighteen months after the apparent cure of an aneurism by pressure. The tumour had become stationary, and had given him no further trouble. The opening of the artery out of the aneurysmal tumour is seen just below the letter *a*. The artery itself is perfectly pervious throughout; *b* shows the internal popliteal nerve. Almost the whole of the sac is seen to be occupied by laminated clot. (From a preparation in the Museum of St. George's Hospital. Series vi. No. 122.)

artery and joint, and is entirely filled with laminated coagula, except a channel at the back continuous with the artery and forming a part of its tube. This method of cure is, however,

not to be desired, since the clot may yield again to the force of the circulation,* and thus the disease may recur.

The failure of this method is due sometimes to the anatomical distribution of the arteries, as, for instance, when a *vas aberrans* carries on the circulation though the aneurism from a point above that which is compressed, and probably with more energy the more the main trunk is obstructed;† or it is due to sloughing of the skin under the pressure, to the patient's indolence or constitutional restlessness (by far the most frequent cause of failure), or to some deficiency in the tendency towards coagulation, which renders the blood in the sac incapable of going through the processes necessary for a cure without a more complete interruption to the circulation than gradual compression furnishes, and which must therefore be sought by total compression or by ligature.

One great advantage, however, of the treatment by compression is, that when it fails it seldom fails totally; for if it does not succeed in curing the aneurism, yet in almost all cases it places the disease under more favourable conditions for cure. The obvious reason is, that it produces enlargement of the collateral vessels, and thus obviates the tendency to gangrene which is so decided in the lower extremity after the Hunterian operation upon the femoral artery. It seems highly probable, therefore, although at present the cases are too few to form any conclusion, that the mortality from gangrene will be found much smaller in cases treated first by compression, and afterwards by ligature, than in those where the artery has been tied at the outset.‡

Compression, however, although it is usually harmless, if not beneficial, even in the cases where it is not entirely successful, is not always so. Cases do no doubt occur in which the aneurism increases with much greater rapidity after the application of the pressure, and goes on rapidly to bursting. In one such case the skin gave way, and the patient died of hæmorrhage.§

* See Mr. Spence's case, quoted on p. 500.

† The case marked 24 in Dr. Bellingham's table (*Med.-Chir. Trans.* vol. xxxiv. p. 149) is an example of this peculiarity.

‡ *Med. Times and Gaz.* Nov. 29, 1856. It might occur to the reader that this advantage will be in some respect balanced by the increased facility with which the blood would find its way into the artery above the sac, and thus carry on the circulation through it; but this does not seem to have been the case in any of the aneurisms so treated.

§ *Med. Times*, 1860, vol. i. p. 118.

As to pressure on the distal side of the sac, it appears in some cases to be very useful as an auxiliary to complete compression of the artery leading to the aneurism; but as the essential measure for the cure of the disease, it is not to be trusted. Still, trial may be made of this plan in aneurism at the root of the neck, where direct pressure might be dangerous, and where pressure between the heart and tumour would be impossible.

DIGITAL COMPRESSION.

The treatment of aneurism by digital compression is of very recent origin. It has sprung directly from the successes, and it must be said, also from the failures, of the treatment by mechanical compression.

The first recorded case in which digital compression was successfully employed for aneurism appears to be that of a patient treated by Mr. Greatrex in May 1844, and whose case was recorded by that surgeon in the *Medico-Chirurgical Transactions* for 1845. In this case the thumb or fingers were applied over the femoral artery in the intervals of compression by a tourniquet. The aneurism, which filled the popliteal space, solidified in twenty-four hours under this joint treatment by digital and instrumental compression. Two years later, Professor Jolliffe Tufnell,* treating a popliteal aneurism by compression with a tourniquet at the groin, found his progress impeded by enlargement of the inguinal glands, and taught his patient to compress the femoral artery with his thumb until the swelling of the glands subsided. In both these cases the pressure by the finger was employed as a temporary aid to instrumental compression, rather than as a means capable of effecting the cure of an aneurism.

But in 1848 Dr. Knight† of Newhaven, United States, for the first time employed compression of the femoral by the fingers as the sole means of cure. The case was one of popliteal aneurism in a mulatto forty-eight years of age, for whom every kind of tourniquet and apparatus had been vainly employed. Before having recourse to ligature, Dr. Knight made trial of manual compression of the femoral; he obtained the help of a number of assistants, who relieved each other, two and two every half hour, maintaining continued pressure to an extent which arrested pulsation in the tumour. At the end of forty hours the tumour was one-third smaller, hard, and pulseless. Compression was stopped, the cure was complete, and four months afterwards the tumour could hardly be felt. This success of Dr. Knight gave rise to other efforts in America. Mr. Fox,‡ in Pennsylvania Hospital, applied digital compression to the treatment of an inguinal aneurism soon after the publication of Dr. Knight's case. He desisted from its employment, owing to the want of assistants, although much success had attended the trial. Mechanical compression was

* *Dublin Medical Press*, 1847, vol. i. p. 169.

† *Transactions of the American Medical Association*, 1848, p. 169.

‡ *American Journal of Medical Sciences*, 1849, vol. xxxvii. p. 377.

not well borne, and ultimately the external iliac was tied. His example was followed in the same year by Professor Willard Parker* and Dr. J. R. Wood,† of New York, who achieved successes in the treatment of femoral and popliteal aneurisms by the combination of digital and mechanical compression.

During this interval the Dublin surgeons had not published any case in which digital compression was employed. In 1852, Mr. Norgate‡ recorded a case of popliteal aneurism, in which pressure by the thumb was temporarily employed in succession to mechanical compression. The tumour ruptured, and amputation was resorted to with success. And in 1854 Jameson§ obtained a cure by the mixed methods; he employed a Reid's compressor during six days ineffectually, introducing with successful effect six hours of digital compression. In another instance, Donohue, a patient of Mr. Colles in the Meath Hospital, Dublin, observing that by compressing the femoral artery in the groin he eased the pain of a diffused popliteal aneurism, quietly performed the compression during three days, so that when the surgeon came to fit on a tourniquet he found that his patient had cured himself.||

In Italy, Professor Vanzetti, of Padua, obtained, at this date (November 1853), a striking success in the treatment of popliteal aneurism by manual compression; his patient was a healthy man, aged nineteen, the subject of a right popliteal aneurism of the size of an orange, and of five months' duration. Methodical compression was made, by the hands of assistants, at the apex of Scarpa's triangle, and solidification of the tumour was effected in forty-eight hours, without pain and without diminution of the temperature of the limb. In 1855 Professor Vanzetti treated a second case of popliteal aneurism, in the person of a young officer, by similar means and with even more striking success. It was a spontaneous popliteal aneurism of two months' date; the knee was much bent. The patient himself was taught to compress the femoral artery, during three weeks, and many times daily, each time from six to eight minutes; partial solidification followed. Methodical compression of the femoral artery at the same point, as in the former case, was then applied during five hours, with the effect of solidifying the tumour, and affording a complete cure. Professor Vanzetti, in recording these cases, mentions also that he applied the same method to the treatment of popliteal aneurism at the hospital of Karkof in Russia, in 1846.¶ After two days, finding it unsuccessful, he passed at once to the ligature. It will be observed that, although unsuccessful and not published until 1858, this was the first attempt at curing an aneurism by manual compression solely; just as Dr. Knight's case, in 1848, previously mentioned, was the first instance of a cure actually effected by the sole use of pressure by the hand. Hence Professor Vanzetti claims a priority as inventor of digital compression, which has commonly been accorded to Dr. Knight.** The merit of strongly insisting upon the value of digital compression, and studying its applications to surgical treatment with a success which fixed the attention of

* Broca, p. 809.

† *Dublin Medical Press*, 1846, p. 150.

‡ *Ibid.* 1852, vol. xxvi. p. 247. § *Ibid.* 1854.

|| *Ibid.* May 1, 1854, p. 97.

¶ *Annali Universali di Medicina*, Jan. 1858.

** *Priorità del Metodo di curare gli Aneurismi colla sola mano, dovuta alla Scuola di Chirurgia dell' Università di Padova, del Prof. Tito Vanzetti.* *Annali Universali*, vol. clxiii.

European surgeons, is undoubtedly due to Vanzetti. These early successes were speedily followed by others equally remarkable. In July 1856, a female patient came under the care of Professor Gioppi,* of Padua, the subject of aneurism of the ophthalmic artery; the case was one of great severity. The portrait of the patient fully confirms the written descriptions: the eye projected on to the cheek; it was motionless; the cornea was infiltrated and opaque; the sight was gone. The pulsating aneurismal tumour could be felt by introducing the finger between the globe of the eye and the roof of the orbit; the bruit could be heard loudly. The carotid was compressed for periods of a minute or two, and, with frequent intervals, by the convalescents of the ward and by the patient herself. Pressure continued for more than a minute produced fainting. Nevertheless, at the end of one day there was a visible improvement, and at the end of four days all pulsations had ceased. Four months afterwards the eye rested and moved naturally in the orbit; vision was restored, the patient remaining only somewhat short-sighted, and with the pupil slightly dilated. A second case, in which a formidable aneurism of the ophthalmic artery, in a patient the subject of aortic and cardiac disease, was cured by digital compression, was published, in 1858, by Drs. Vanzetti and Scaramuzza.† Intermittent compression of the carotid by the finger was here also employed for five minutes at a time, and cure was effected by seven hours and twenty minutes of compression spread over eighteen days. These brilliant successes, real triumphs of conservative surgery, supported as they were by abundant and irrefragable testimony, sufficed to place digital compression amongst the most precious resources of surgery in the treatment of external aneurism.

The subsequent experience of surgeons who have employed this method since Vanzetti affords numerous instances of cure, unrivalled for simplicity, painlessness, ease, and rapidity in the records of the treatment of aneurism by any other means. In nineteen cases successfully treated by digital pressure, the average number of hours of pressure was not more than forty-one and a half—spread, however, over a variable period of time, owing to intermissions of the pressure. In a case which came under my own notice in 1868, the patient, a policeman, had had a popliteal aneurism cured in Guy's Hospital, under Mr. Bryant's care‡ by digital compression in about twenty-four hours. He returned to his duty, and in about a year afterwards a second aneurism formed in the opposite ham. Of the nature of this tumour there could be no doubt, since it was verified by his usual medical attendant, who had previously placed him under Mr. Bryant's care. The man went to bed, and imitated so successfully with his own thumb and fingers the treatment he had seen pursued in the hospital, that he suppressed the pulsation in the sac completely and finally in four and a half hours. When I saw him there was no trace of the tumour

* *Annales d'Oculistique*, 1857.

† *Secondo caso di Aneurisma dell' Arteria ottalmica guarito colla compressione digitale della carotide*, &c., del Dott. T. Vanzetti, &c. &c. Padova, 1858.

‡ *Guy's Hospital Reports*, series iii. vol. xiv. p. 241. A case of traumatic aneurism of the femoral artery, under M. Chassaignac's care, cured in seven hours by digital compression, is related in *L'Union méd.* Dec. 2, 1862. Here, however, the compression was continued as a precaution more or less during the next twenty-four hours.

beyond a little thickening in its old situation. Mr. Bryant informs me that he has since met with another case in which the patient had cured himself in the same manner.

Digital pressure ought to be effected, when possible, by the united efforts of a staff of trained assistants (in hospital practice, usually medical students), who should make pressure in pairs each for about ten minutes, relieving each other alternately. The one who is not compressing should see that the other holds the artery firmly, and commands the circulation through the tumour completely during the whole period. The point of pressure should be varied whenever that is possible, and great care should be taken to impress upon the assistants, especially if they are entirely ignorant of medicine, the proper direction of the pressure by which the artery can be held with the least force, and the great importance of not using more pressure than is absolutely necessary. A reasonable time must be allowed for sleep, at least in most cases, undisturbed by pressure. Some patients can tolerate the constant application of the compression for a day or two. It should not be forgotten that digital pressure is by no means always painless, but on the contrary sometimes more painful than instrumental compression. In such cases it should be given up, and the latter method substituted.

The cures, however, which are effected by digital pressure are often very rapid and attended with less pain than any of the other methods; and this kind of compression can occasionally be applied to arteries, such as the carotid, where mechanical pressure is hardly practicable.

TREATMENT BY FLEXION.

The simple bandaging of the limb in acute flexion, the patient being kept at rest, may occasionally succeed in curing aneurisms situated at the bend of the limb, as in the popliteal space or the elbow, and possibly in the groin. This plan of cure had been previously tried; but the merit of first demonstrating its success is fairly due to Mr. Ernest Hart.* All that is requisite in this

* For the details of this case, which I had the opportunity of seeing, in consultation with Mr. Hart, before the commencement of the treatment, see *Med.-Chir. Trans.* vol. xlii. p. 205. In the same volume is the report of a similar successful case under the care of Mr. Shaw. The plan is understood to have been tried some time ago on a patient of Sir W. Fergusson at King's College Hospital; but it seems likely that the trial was not very persistent. The

treatment is to bandage the limb from the toes nearly to the knee with a roller, and then to turn the roller round the thigh flexed at an acute angle; the limb should then be bent upon the pelvis, and the knee rested against a pillow.

In Mr. Hart's case, the cure had made considerable advance after the first day of the treatment, and was complete on the fourth day; on the seventh the patient was moving about. In Mr. Shaw's case, the cure was much more protracted, and the cessation of pulsation was not reported till the thirty-eighth day, but then the tumour was larger. In neither of these cases was any rigorous system of diet enforced, nor did the patient complain of the least inconvenience in either. In a patient under my own care,* the aneurism, which was small and recent, was cured, without any inconvenience or distress to the patient, in two days. Numerous other successful cases have been put on record. The most interesting and important of these, in which genuflexion succeeded after the failure of the Hunterian operation, and of instrumental compression on the femoral artery, is reported by Mr. Spence in the *Edinburgh Medical Journal* for November 1859, p. 434. The patient had applied for advice originally in May 1857, on account of an aneurism, which had only been noticed a month, and which increased so rapidly while he was under observation, that the femoral was tied below the origin of the profunda without further delay. There was some apprehension of gangrene after the operation, showing apparently that the circulation was re-established only slowly. The ligature separated on the twenty-ninth day, and then some undulatory pulsation was noticed in the tumour, which, however, was much diminished in size. By bandaging the limb, cautious compression of the femoral artery, and direct pressure by a compress of lint over the tumour, this pulsation was reduced to a line corresponding to the course of the artery, and not larger than the popliteal on the other side. The patient was then discharged, and returned to his avocation, that of a coal-carter. In August 1858 he came to the hospital again, as the tumour had suddenly increased within two or three days. It was then found to be as large, and pulsating as violently, as before the artery was tied. Compression was tried, and persisted in for five months, but the tumour increased instead of diminishing. It was then proposed to tie the femoral artery low down, *i.e.* in Hunter's canal, since the upper part of the superficial femoral appeared obliterated. Previous to this, however, it was thought right to give a trial to the flexion treatment; and this succeeded so well, that in a week the pulsation had very much diminished, and in a month the aneurism was quite cured, its contents being perfectly solid, and the anastomosing vessels enlarged. The man again returned to his laborious avocation, and was presented to the Medico-Chirurgical Society of Edinburgh four months afterwards; the cure being quite complete.†

details have been lost; and the fact was first mentioned after the publication of Mr. Hart's case. Mr. Hart's case occurred in 1858. It seems, however, that the method was successfully used by Dr. Th. Maunoir of Geneva, in 1857. See Richet, in *Dict. de Méd. et Chir. pratique*, vol. ii. p. 339.

* *Brit. Med. Journ.* 1868, vol. i. p. 585.

† A second case, under Mr. Hart's care, was communicated to the Royal Medical and Chirurgical Society, in which the cure was effected in a few days without

It ought to be noticed here that this man could not at first bear the complete flexion of the limb; accordingly a slipper, with a piece of bandage sewn to the heel, was fastened on the foot, and the bandage was then attached to a loop connected with a broad band round his pelvis, and this loop was gradually tightened, so as to increase daily the flexion of the leg on the thigh. The confinement to bed appears to have lasted little more than a fortnight. This milder plan of employing flexion may be often found successful when the patient cannot tolerate more rigid confinement.

Many cases are also reported in which flexion has been successfully used in combination with pressure. In one under the care of Mr. Pemberton,* the amount of pressure used was so slight that no great importance is attached by him to its action. Yet the aneurism, a large one, and pulsating strongly, was cured in less than twelve hours. A somewhat similar case is reported by Mr. A. Pritchard of Bristol, in the *British Medical Journal*, March 30, 1861.†

The failures which have hitherto been recorded appear not beyond what any other method of treatment is exposed to.

Thus in Mr. Moore's case, above referred to (p. 483), flexion was tried unsuccessfully; but then the tumour was large, and was growing rapidly towards the joint; and such cases are peculiarly intractable. In a case under Mr. Paget's care,‡ this method was tried, and failed; but in that case other methods of treatment also failed, the case not being one of aneurism in the proper sense of the term, but of ulcerated artery without a sac.

A case was in St. George's Hospital in 1867 of popliteal aneurism of two months' duration, in a man aged twenty-six, of dissipated habits. Flexion to about a right angle, nearly but not quite stopped the pulsation. After eleven days of flexion the pulsation had ceased entirely. It recurred, however, though to a very slight extent, from time to time, and the limb continued to increase in size, until a portion of the swelling suppurated; and then bleeding occurred from the tumour, necessitating amputation. On examining the limb the artery was found completely divided into two parts. No mention is made of any obvious disease in the coats of the artery.

M. Liégois § gives an analysis of forty-nine cases of popliteal aneurism treated by flexion, founded on a thesis by M. Stopin. Twenty-six were cured, flexion being used alone in eleven cases, and in four after other methods had failed. In the remaining eleven flexion was used in combination with other measures. Out of the twenty-three cases which failed, seven are stated to have suffered rupture, and one inflammation of the sac.

The cases best adapted for the trial of flexion are the simplest. In those cases where the tumour is not of very large size, where the parts covering it are not much inflamed, nor the joint in-

even confinement to the recumbent position. (*Proceedings of the Royal Med. and Chir. Soc.* vol. iv. p. 37.)

* *Lancet*, Sept. 3, 1859, p. 232.

† See also a case by Mr. Colles, in the *Dublin Hospital Gazette*, June 15, 1860; and one by Dr. Leith Adams, *Med. Times and Gazette*, Jan. 26, 1861.

‡ *Medical Times and Gazette*, 1859, vol. ii. p. 505.

§ *L'Union méd.* August 14, 1869, p. 236.

volved, and where, as far as can be ascertained, the tumour is seated on the superficial face of the artery, we may anticipate benefit from flexion. If the flexion of the limb entirely, or almost entirely, suspends the pulsation and the bruit, this treatment may be trusted by itself; otherwise a compressor must be applied to the artery above, in aid of the flexion. But the compression need not, in such a case, be applied with nearly the same severity which would be demanded in an ordinary case.* A very slight amount of pressure will often serve; and if the only advantage of this simple and nearly painless proceeding were to spare the patient the annoyance of severe pressure, it would be no slight one. There are, however, many cases in which the aneurism will be entirely cured by it, without the smallest risk either to life or limb.

TREATMENT BY MANIPULATION.

A method of treatment has been founded on the consideration of the pathological changes which by the deposition of fibrine and occlusion of the cavity of an aneurismal sac lead to its cure, and the analysis of certain cases in which the accidental displacement of clot from within the sac, and its impaction in the artery on the distal side of the aneurism, has seemed to give rise to exceptional cures. Sir W. Fergusson has endeavoured artificially to imitate this process by means of a particular manipulation of an aneurism, whereby the fibrine within may be so displaced as, either in part or in whole, to block up the main artery on the distal side of the disease.

In a paper, which will be found in the *Medico-Chirurgical Transactions*, vol. xl. p. 1, that surgeon describes two cases which he submitted to this treatment. Both were cases of subclavian aneurism. The first patient was a healthy-looking man of middle age, having a large aneurism of two years' standing, involving chiefly the middle part of the artery. In the event of any operation by ligature having been determined on, the vessel must have been tied either on the tracheal side of the scaleni, according to the Hunterian method, or on the distal side, according to the method of Wardrop or Brasdor. Sir W. Fergusson thus describes his proceeding: 'The patient was seated in a chair: and I placed the flat end of the thumb on the aneurismal tumour so as to cover the prominence. I then pressed, until all the fluid blood had passed from the sac, and I could feel that the upper side of the aneurism was pressed against the lower. I now gave a rubbing motion to the thumb, and felt a friction of surfaces within the flattened mass. The movements were little more than momentary, but they were such as I had preconceived.' The immediate affect was to produce giddiness and mental confusion, so that the patient was

* See Mr. Pemberton's case, above referred to.

for a time unable to stand. Pulsation ceased in the arteries below the tumour, and pain was experienced in the hand and forearm. In the evening, however, pulsation had returned in these vessels. Next day the manipulation in the way described was repeated, with much the same immediate effects. Pulsation returned slowly, after some days, in the arm and hand. The tumour was thought to have become manifestly less in size, and to pulsate less strongly. It never ceased, however, to pulsate, and eight months after, the patient died, owing to rupture of the sac at the lower and back part. It was found to contain solid fibrine of old date, and recently coagulated blood. The axillary artery was filled with a firm plug of fibrine. In the second case so treated by Sir W. Fergusson, paralysis of the left side of the face, and of the left forearm and leg followed the first manipulation, the pulse ceasing at the wrist. With this exception there was little material change. At the end of two months the patient resumed his occupation as a seaman, having regained the use of his left side; but the tumour being apparently unaltered. A year after, he was again seen, and an attempt made to keep up continued pressure on the tumour; but it proved so unsatisfactory, that it was given up. Again, at the end of the year, that is, two years after the first employment of manipulation, he returned; and now the tumour had completely disappeared, there was not a trace of it to be perceived; a slight pulse could be felt at the wrist. The arm seemed much the same as its fellow, and the paralysis of the left side had gone off.

Neither of these cases afforded satisfactory evidence of the efficacy or safety of this mode of treatment. In the first case, although the tumour was considered to be somewhat solidified, it never ceased to pulsate; and after a few months caused the death of the patient by bursting. In the second case no perceptible effect was produced on the tumour at the time, nor did it seem to be much changed at the end of a year; but after two years of laborious occupation, the tumour was found to have disappeared. It must be considered doubtful how far this result was due to spontaneous changes, or to accidental displacement of the contents of the tumour in the course of the patient's frequent exertions.

The sudden faintness of both these patients immediately after the manipulation of the tumours, and the paralysis which followed in the second case, indicated sources of danger connected with this treatment, which Sir W. Fergusson did not omit to point out. It seemed possible that in the manipulation some of the broken-down fibrine was squeezed towards the mouth of the vertebral or carotid arteries, and by obstructing the flow of blood to the brain produced hemiplegia in the manner suggested by Dr. Kirkes, who, in a paper read before the Medical and Chirurgical Society in May 1852, pointed out the probability of this condition being produced by fibrine from the valves of the aorta being carried along mechanically in the blood. A case

highly illustrative of this danger has since been described by Prof. Esmarch.*

Captain C. H. consulted a friend of Prof. Esmarch's for tonsillitis, and at the same time drew his attention to a tumour on the left side of his neck, which had formed suddenly three years previously, without appreciable cause, and had now attained the size of a hen's egg. It was easily diagnosed as an aneurism of the common carotid. On repeating the examination a few days later, and exerting pressure upon the tumour for the purpose of reducing it, the patient fell suddenly back with symptoms of apoplexy; he was at once bled, and conveyed to the hospital, where he was placed under the care of Dr. Esmarch. There was right-sided cerebral paralysis; the pupils were dilated, but reacted to the light; the tumour pulsated simultaneously with the carotids, but presented no murmurs. Prof. Esmarch diagnosed the detachment of fibrine from the aneurismal sac and consequent obliteration of the left carotid. Death ensued three days afterwards. At the autopsy, performed by Prof. Weber, of which the most careful details are given, the sac of the large aneurism was found to be partly lined with more or less firmly attached, ragged, fibrinous coagula; much loose fibrine irregularly interwoven was also in the sac; a firm coagulum was drawn out of the internal carotid, and this coagulum was found to extend up to the carotid foramen. There was no coagulum in the external carotid. The cerebral carotid, the middle cerebral, and the ophthalmic artery were completely blocked up with coagula of a dark-brown colour, enclosing numerous red and greyish-white plugs, which evidently were derived from the aneurism. Their identity was proved by the microscope. There was considerable softening of the middle of the left hemisphere, including the corpus callosum.

A somewhat similar accident was described by Mr. Teale of Leeds, in some clinical remarks delivered in 1859.† He mentions that in the year 1847 he was one of a numerous consultation in a doubtful case of carotid aneurism. The subject of it was a middle-aged female, in good health in other respects. She was seated in a chair while the tumour was examined by several persons in succession, and subjected by them to repeated handling and compression. While this was going on, she suddenly became pale and slipped off the chair. On being raised, she was found to be hemiplegic; after lingering in this state a few weeks, she died. The tumour was found after death to be aneurismal.

These two cases serve to show very strongly the dangers which, as Sir W. Fergusson himself pointed out, are likely to follow the manipulation of aneurismal tumours of the neck. On the other hand, subclavian aneurisms are almost always ultimately fatal, and have never yet been successfully treated by the Hunterian ligature.

Soon after the publication of Sir W. Fergusson's paper, Mr. Robert Little ‡ admitted into the Donegal Infirmary an Albino, aged fifty-three, having an aneurism of the right subclavian artery, of nine months' duration, of consider-

* Virchow, *Archiv für Path. Anat. und Physiologie*, vol. xi. p. 410, 1857.

† *Med. Times and Gaz.* March 1859, p. 265.

‡ *Med. Times and Gaz.* May 23, 1857.

able size, pulsating strongly, having a loud bruit, soft and compressible, somewhat red and inflamed on the cutaneous surface. Anodynes, sedatives, local refrigerants, and venesection were employed without effect. On January 1, 1856, by making gentle but steady pressure with the thumbs alternately over the aneurismal sac, Mr. Little succeeded in displacing some of the coagula, and directing them towards the distal opening of the artery. No other local treatment was adopted; but the patient was ordered a preparation of iron internally. For the first two days no change was perceptible either in the tumour or the arm; but on the third day the pulse at the wrist was manifestly weaker, and the arm somewhat colder than the opposite one. The symptoms gradually increased up to the tenth day after the manipulation of the sac, when no pulsation could be felt in either the radial, brachial, or axillary arteries. From this time the tumour itself gradually became more solid, and finally all pulsation ceased. The tumour wasted to the size of a small walnut, and two superficial arterial branches could be traced running transversely across it; one immediately above the clavicle, the other somewhat higher up. For a time the arm was partially paralysed and very cold, but it subsequently recovered sensation and motion; and when the patient was seen a year afterwards, his cure was in all respects complete.

In addition to this highly satisfactory and interesting cure, Mr. Teale of Leeds, and Dr. G. E. Blackman of Cincinnati, have each successfully treated an aneurism of the lower extremity by manipulation. Dr. Blackman* received under his care, in April 1857, a man, the subject of a large femoral aneurism, measuring five inches at the base. After forcibly manipulating the tumour with the view of dislodging the fibrinous contents, a Skey's tourniquet was applied to the femoral artery immediately below Poupart's ligament. Much pain was complained of in the tumour, and the pulse rose to one hundred and ten, being full and strong. The patient was bled to nine ounces, with the effect of diminishing the pain, and bringing the pulse to fifty, soft and regular. After four days the tourniquet was taken off, the leg was bandaged, and as the pulse was still high, venesection was again employed, and opium and tartarised antimony administered internally. On the tenth day pulsation had altogether ceased. The cure remained good. The femoral artery is described as being plugged as far as the origin of the profunda, while in the popliteal space the pulsation of the artery was hardly perceptible.

It is not, however, very easy in this instance precisely to define the respective effects of the treatment by compression and that by manipulation, although the latter may be considered to have played an important part in producing the cure.

In the case treated by Mr. Teale compression of the femoral at the groin had been employed for some days, in the treatment of a popliteal aneurism, with the effect of producing some deposition of fibrine in the sac and enlargement of collateral vessels; but no material improvement having been effected, Mr. Teale attempted to produce displacement of the fibrine in the sac by moderate manipulation. The first attempt excited little change; he then repeated the manipulation with greater freedom, 'kneading the tumour in various directions.' An hour and a half after the last manipulation, the tumour had entirely ceased

* *Western Lancet*, June 1857; *New York Journal of Medical Science*, 1857, p. 291.

to pulsate, and had become a solid mass. Eleven days subsequently, the patient left the hospital cured, the tumour having decreased rapidly in size, and he having been able to walk about the ward a few days.*

From the data furnished by these cases, which are the only ones bearing on this mode of treatment which I have as yet met with, a judgment may be formed of the uses and dangers of the ingenious but somewhat hazardous practice of manipulation in the treatment of aneurisms.

TREATMENT BY GALVANO-PUNCTURE.

In the preceding modes of treatment of aneurism it is proposed to effect a cure either by retarding the course of the blood, or by introducing elements which favour the precipitation of its plastic principle. Galvano-puncture aims at producing such a modification of the contents of the sac as shall favour slow coagulation, without incurring the risk of introducing into the circulation foreign and perhaps injurious matters. This end it occasionally accomplishes; but it is not without its own peculiar accidents and dangers. Thus out of fifty cases of aneurism so treated, collected by Ciniselli,† twenty-three were cured, twenty were not cured, and in seven instances death resulted. Indeed, the first applications of electro-puncture made by Benjamin Phillips,‡ Liston, and Gérard, in 1838, and the subsequent essays of Mr. Keate,§ were so little successful as to discourage further trials; and but for M. Pétrequin,|| whose persevering application of this plan was, in 1845, followed by success, the procedure might not yet have found a place in practical surgery. Since the publication of those cases, repeated applications of this method have been made to all kinds of aneurism. But although these have served to show clearly the power of electricity to effect the cure of aneurisms, they have shown also very clearly the danger and accidents to which it may give rise. It is a radical defect of this procedure that it acts by inducing direct (or 'passive') coagulation of the blood in the sac. Hence it is inherently uncertain, liable to cause relapse by the melting of

* *Med. Times and Gaz.* p. 265, March 1859.

† *Sulla Elettropuntura nella cura degli Aneurismi*, by Dr. L. Ciniselli. Cremona, 1856.

‡ *Experiments showing that Arteries may be obliterated without Ligature*. See the work of Phillips, London, 1832; and his Letter claiming priority of invention, in the *Archives gén. de Méd.* 1847.

§ *Lancet*, 1837-8, vol. ii. p. 668.

|| *Compte rendu de l'Acad. des Sciences*, 1845, vol. xxi.

the coagulum, or inflammation by its too sudden deposition. Again, it is very liable to set up inflammation in the walls and contents of the sac. Then, too, the needles sometimes produce eschars at the points of their insertion, and thus give rise to consecutive hæmorrhage. In Ciniselli's Table, referred to above, the result of the forty-three cases which survived the operation is thus stated: of the twenty-three cured, six were the subjects of grave accidents, seventeen recovered without or with slight accidents; of the twenty who were not cured, seven were the subjects of grave accidents, thirteen recovered without or with slight accidents. In fact, the cases are few in which a perfectly happy result has been obtained; but some of these are worthy of particular attention.

Thus a subclavian aneurism, forming a tumour as large as a hen's egg beyond the clavicle, was cured by this method by Dr. Abeille.* The success of this case alone, the size of the vessel affected, its proximity to the heart, the rapid increase of the tumour, and the coincidence of constitutional disease, would suffice to give importance to the method by which it was cured. Again, the successful application of galvano-puncture by Nélaton to cirroid aneurism,† and to varicose aneurism at the elbow by Voillemier, afford instances of success in the treatment of varieties of the disease not very amenable to other modes of treatment. Two cases are recorded in which galvano-puncture has been employed with some success in the treatment of aneurism of the ascending aorta; in one with the result of producing what is described as 'a very sensible and evident improvement,'‡ while in the other the improvement was so great that the patient appeared at any rate temporarily cured.

This latter case is so striking, and so well illustrates the method, that a short abstract of it will be offered. It is reported by Signor Ciniselli, in the *Gaz. des Hôp.* Nov. 17, 1868. The aneurism was of the ascending aorta on the right side, and was rapidly increasing; the third and fourth ribs, and the intercostal space between them were much pushed outwards by the tumour; its pulsations were powerful, and very perceptible to the eye as well as to the touch. The patient could not lie on his back, was much troubled by loss of sleep, and quite unable to follow his occupation. At the same time the absence of alteration of the voice, and of obstruction to the jugular veins, with the limited extent over which pulsation could be felt, rendered it probable that the aneurism was not of any large size. Three polished steel needles were buried in the tumour, each penetrating the sac of the aneurism to about an inch in depth. The positive pole of the battery was first applied to each needle in succession, the negative pole being placed in contact with the skin over the

* *Archives gén. de Méd.* Aug. 1849.

† See infr. Cirroid Aneurism. See also an interesting paper by Dr. Duncan, *Edin. Med. Journ.* April 1866.

‡ *Gaz. Medica di Milano*, 1847, No. 2; *Ibid.* 1850, No. 33; *Gaz. Medica Ital. Lombard.* 1850, No. 44. Another case quoted here was unsuccessful.

tumour. This precaution is said by Ciniselli to prevent the formation of eschars. The electric-current was procured from a pile formed of thirty square couples, each side measuring ten centimetres (about three inches), steeped in a solution of sea-salt. The current was directed down two of the needles for ten minutes each, and the other for five minutes, the whole proceeding lasting forty minutes. The withdrawal of the needles was followed by a little bleeding, easily checked by saturnine compresses and ice. The same means also reduced the redness and swelling, which was the only sign of local reaction. No general symptoms followed. The tumour rapidly diminished in prominence and in pulsation; the patient could lie on his back, and was able to sleep almost immediately after the operation. The aneurismal bruit, which had been very loud, also gradually disappeared, and it seemed that the tumour had become solidified, though some pulsation could be still felt, which was thought to be that of the aorta transmitted through the solidified mass. He was kept quiet as long as possible; but ten weeks after the operation, feeling himself quite well, he resumed his occupation, that of a coachman.

From the study of numerous collected cases, it may be seen that the *modus operandi* of galvano-puncture in cases where cure has followed its application, has not always been identical. In some instances, the introduction of the needles into the sac and the application of the current has apparently been followed by the formation of a clot which only partially filled the aneurismal sac; and by virtue of the power which freshly deposited fibrine has of attracting to itself fresh layers of fibrine from the circulating blood, the clot has gradually increased in size, until the tumour was solidified and cure effected. This is the most favourable sequence, and may be regarded as the typical result. But this sequence is rare. In other cases, at the end of the sitting the sac is already filled with a more or less solid coagulum; sometimes this melts, sometimes it remains permanent and yields a cure. Most commonly, however, the introduction of the needles has been followed by symptoms of inflammation within the sac, and the cure has been due to the effect of this inflammation. Either coagulation has slowly followed upon the inflammatory action, or suppuration and obliteration of the sac has been induced. The pain of the operation is in most cases very considerable.

Dr. Althaus* has described a form of battery which is very portable and convenient for the removal of tumours, and the

* *On the Electrolytic Treatment of Tumours and other Surgical Diseases*, p. 12. Dr. Althaus differs from Ciniselli, believing that the negative pole only ought to be brought into contact with the blood in the sac. He gives no case of his own, but cites an instance in which an aneurism was thus cured—though by mistake, for the operator had intended to apply the positive pole.

treatment of other forms of disease by electricity. By immersing only the needle connected with the negative pole of this apparatus in the sac, he believes 'a foreign body may be safely deposited in the sac, round which we may expect a slow and gradual deposit of laminated fibrine to take place.'

All these methods of cure must be considered as less satisfactory than those in which deposition of stratified fibrine is slowly obtained. The risk of exciting inflammation in the sac and its contents is a very serious hazard, and the statistics of this method practically confirm the objections which we may adduce simply from a knowledge of its mode of operation.

Galvano-puncture appears, then, at present to deserve to rank only as an exceptional expedient. Its claims will have to be considered by the practical surgeon principally when he is called upon to treat either aneurisms at the root of the neck, or internal aneurisms which cannot be reached by digital or mechanical compression, and some forms of varicose and cirroid aneurism seated superficially. The dangers and imperfections of the process must restrict its application even in this limited field. But as a resource available in cases where neither compression nor ligature can be advantageously applied, it has a sphere of useful action.

TREATMENT BY COAGULATING INJECTIONS.

The treatment of aneurism by the injection of a coagulating fluid into the centre of the tumour is so uncertain and so little used that a short account of it must suffice. The first proposal was put forward by Monteggia,* who suggested alcohol, acetate of lead, and tannin as coagulating agents. Wardrop† suggested acetic acid, advising also compression so as to stop the circulation above and below the tumour. But since the experiments of Pravaz on the effects of perchloride of iron, that substance has been chiefly if not solely used. Upwards of thirty cases so treated have been collected; and there can be no doubt of the possibility of thus coagulating a large portion at any rate of the blood in an aneurism. But this cannot be done without great danger. The dangers proceed either from inflammation and abscess, set up in the neighbourhood of the sac, from inflamma-

* *Instituzioni Chirurgiche*, pp. 68, 82, 124. Milan, 1813.

† Costello's *Cycl. of Prac. Surg.* i. 218.

tion of the sac itself, producing gangrene, or rupture of the aneurism, or from the consequences of embolism. In eighteen collected cases, the injection proved fatal four times; twice from gangrene of the limb, once from hæmorrhage following gangrene of the sac, and once from phlebitis. This is a formidable roll of accidents and a large proportion of deaths. It will seem yet larger, when we remember that it is a condition of primary necessity now recognised by all surgeons, that before the method of injection can be applied, it must be possible to arrest the current of the blood by pressure on the artery above and below the tumour. Thus it would be possible in nearly all these cases to apply either instrumental or digital compression or flexion; proceedings which can count a larger proportion of successes, and which are not open to the same objections.

The treatment by injection has been applied to nearly every form of external aneurism: to popliteal aneurism, by Niepce, Lenoir, Minor, and Isaacs; to carotid aneurism, by M. Dufour; to aneurisms of the elbow, by M. Jobert, Serres d'Alais, Vallette, and Dieulafoy; and even to aneurisms of the innominate, by M. Barrier; of the subclavian by Pétrequin; and of the aorta by Syme. The last three varieties are totally out of the domain of this method of treatment, because they are inaccessible to the compression of the artery on their cardiac and distal side; and without this precaution, the small clots formed by each drop of the perchloride on its entering the sac, are likely, as has been proved by experience, to be carried by the blood into the ramifications of the artery and produce gangrene. To repeat those experiments would therefore now be unjustifiable. Aneurisms of the popliteal artery, and of the extremities generally, are susceptible of such satisfactory treatment by compression and flexion, that the more dangerous method of injection would here be out of place. An exception, however, must be made for those varicose aneurisms seen most commonly at the elbow after venesection, which have not always proved amenable even to digital compression, and in which deligation is somewhat complicated and difficult. Injection of perchloride of iron has four times been successfully applied to such a condition by Jobert, Serres, Vallette, and Dieulafoy; and proper precautions being used, this method may here be found advantageous. The same may also be said for cirroid and anastomotic aneurism. (See Cirroid Aneurism.)

When in any case it is determined to inject a coagulating

fluid, it is desirable to adopt certain precautions. In the first place, as to the fluid selected. Various preparations of iron, such as the lactate, the persulphate, the acetate of the sesquioxide of iron, tannic acid, alcohol, and acetic acid, have been recommended and employed; but the coagulating power of the solution of the perchloride is so much greater than that of any of these fluids, that it obtains the preference, notwithstanding its irritating qualities. In order to reduce this irritating action to its minimum, it is desirable to employ a neutral solution of the perchloride and one of feeble dilution. Very careful directions have been given for the preparation of the solutions by M. Burin-Dubuisson,* M. Soubeiran,† and others. In the earliest cases a solution was employed of the strength of 45°—49° Beaumé, *i.e.* sp. gr. 1·454 — 1·526; but experience has shown that solutions of this strength are productive of excessive inflammation, and lead almost inevitably to grave accidents. The experience of M. Valette has shown that a solution of twenty degrees possesses great coagulating power, and no higher degree of strength should be employed. Care also should be taken not to inject an excess of the perchloride; for this not only inflames the tissues of the sac, but diminishes the solidity of the clot. M. Broca advises the injection of twenty drops to every centilitre (100th of a pint) of the contents of the aneurismal sac. The recent experience of M. Dieulafoy (1859) seems to show that one-tenth of this quantity may suffice; and that for an aneurism containing twelve centilitres, or three and a half ounces, eighteen to twenty drops only need to be injected. The best instrument for the purpose is the small graduated syringe with screw piston and glass body, made for the purpose by most instrument-makers, and also used for subcutaneous injections. In performing the injection, it is necessary first to establish accurate compression of the artery above and below the tumour, so as completely to arrest the blood in it. The pointed trocar is plunged perpendicularly into the tumour, care being taken on the one hand to enter the cavity, and on the other not to transfix it, both of which accidents have happened to experienced operators. The success of the step is indicated by the issue of *arterial* blood, an indication which should be looked for. The cannula is now screwed on to the trocar, and so much

* *Compte rendu de l'Acad. des Sciences*, Jan. 16, 1854, vol. xxxviii. p. 89.

† *Bulletin de Thérapeutique*, vol. xlv. p. 454, 1853; see also *Thèse de M. Jean Pravaz*, Paris. 1857.

as may be thought necessary of the injection is pushed out into the fluid contents of the sac by successive turns of the piston. Each turn is usually equivalent to half a drop, and the quantity injected may be further estimated by a reference to a scale, which should be marked on the glass body of the syringe. The point of the trocar may be directed upwards, downwards, and on either side, without withdrawing it, so as to form several centres of coagulation. When the tumour has acquired a certain consistence and the coagulation has sufficiently taken place, one turn backwards should be given to the piston, so as to draw up the liquid contained in the cannula and to prevent its irritating contact with the tissues; it is then carefully withdrawn. The compression of the artery on the cardiac side of the sac should be continued for an hour.

It is necessary to attend to these precautions very carefully, because experience has shown that owing to their neglect many of those serious accidents occurred which marred the success of the earlier cases. Notwithstanding their observance, it is to be expected that inflammation of the sac, with its attending disasters, will frequently follow the injection of the perchloride of iron; and since this method is mainly applicable to those superficial aneurisms which can be treated by other proceedings not open to that objection, and not followed by those dangers, the applications of the treatment by injection are likely to be limited.* The discovery of a fluid of great coagulating power, and devoid of irritating properties, is a desideratum in this method.

INTRODUCTION OF WIRE INTO THE SAC.

Mr. Moore has suggested† a method of inducing coagulation in the sac of an aneurism by means of the introduction of a large quantity of fine iron wire. The object of this proceeding is to detain the fibrine of the circulating blood, and thus to form a clot, much in the same way as in the common experiment of whipping the fibrine out of a mass of blood with twigs.

* In Gurlt and Hirsch's *Jahresbericht*, vol. ii. p. 314, Berlin 1869, will be found a reference to a work by Signor Marsacci on this method of treating aneurism; in which the author relates numerous experiments with all known kinds of coagulating fluids. The conclusion arrived at is that expressed in the text, viz. that the method is one not deserving of confidence, and which it is unjustifiable to employ in cases where compression can be used.

† *Med.-Chir. Trans.* xlvii. 129.

For this purpose Mr. Moore inserted into an aneurism of large size connected with the arch of the aorta, and which was on the point of bursting both into the pericardium and through the skin, twenty-six yards of fine iron-wire. The wire was inserted through a fine cannula, the point of which was moved about during the performance of the operation (which lasted an hour), so as to coil up the wire all round the sac. The cannula was provided with a probe made of stouter wire rounded at the point, and large enough just to fill its tube. This is necessary, both to ascertain as nearly as possible the size and position of the aperture of the sac, and also to push the fine wire out of the cannula into the cavity of the aneurism, for it is obvious that if the wire were left projecting out of the sac, ulceration and fatal hæmorrhage would probably ensue. Rapid coagulation was the consequence of the operation, the aneurism ceased for a time to pulsate, and the pulse-rate diminished from 116 to 78. But this favourable change was transitory: severe inflammation of the sac and parts around soon set in; pulsation and tension returned in the tumour, and the man died exhausted by pain on the fifth day after the operation. On post-mortem examination the proximate cause of death was found to be pericarditis, evidently induced in some manner by the inflammation set up in the large sac, which was in close proximity to the pericardium. There were also scattered abscesses in the kidneys, but whether these were produced by the impaction of clots carried down from the aneurism, seemed, to say the least, doubtful, since traces of a similar action at an earlier period were detected in those organs. The sac was bilocular, a larger pouch lying in front of the bones of the thorax, which had been eroded. This was filled with a firm and adherent coagulum enclosing the coils of wire. The smaller pouch had not been entered by the wire; but a clot projected into this and through it into the artery, part of which had probably formed after death, but a portion was decolorised and laminated. The opening from the inner sac into the aorta was hardly as large as a sixpence.*

I have thought it right to refer to this case somewhat at length as illustrating the latest of many propositions for the treatment of aneurism incurable by the ordinary methods; but I do not feel myself able to pronounce a decided opinion as to whether the proceeding is less or more dangerous, and less or more likely to succeed than galvano-puncture, which is the only other available method in such cases. It must be remembered, on the one hand, that it has only been tried once,† that a very large quantity, probably too large a quantity, of wire was used; and that a very considerable deposit of adherent fibrine was produced, accompanied by great temporary amelioration of the symptoms. These considerations might lead one to hope that in a future trial with additional precautions better

* The coagulum which was formed around the wire is to be seen in the Museum of the Middlesex Hospital. It is almost as large as a cricket-ball, firm, and partially decolorised. A smaller piece of clot is also preserved which projected into the lesser sac and the opening of the artery.

† A very brief report of a case thus treated at Liverpool without success was published, I am informed, soon after Mr. Moore's.

success might be obtained. On the other hand, the history of the case shows unmistakably the great danger and uncertainty of the method, the difficulty of judging of the form of the sac, the position of the opening, the extent of coagulation to be produced, or the effects of its production.

Other surgeons have also tried to induce coagulation by introducing foreign bodies into the aneurismal sac. The operation has always been performed by means of needles, which have been withdrawn when the coagulation has seemed sufficiently far advanced. M. Richet mentions* five cases in which this plan has been adopted, but in no case with any success, and in some with very grave accidents. In another case cited by M. Richet a very small temporal aneurism was treated by inserting two needles and tying a ligature beneath them, as for *nævus*, and with success. This, however, is quite a different matter. M. Velpeau and Mr. B. Phillips, are also referred to by Mr. Moore as having performed experiments to prove that aneurism might be treated in this manner; but I do not find that either ever used acupuncture on the living body, except in combination with galvanism. In my opinion, as far as I am able to judge from the few cases recorded, galvano-puncture is a less hazardous measure, and more likely to prove successful, than acupuncture without galvanism.

TRAUMATIC ANEURISM.

By ‘traumatic aneurism’ is meant a tumour containing blood, communicating with the cavity of an artery, and due to a wound of the vessel. Three descriptions of injury may lead to the formation of a traumatic aneurism: 1, a wound penetrating from the surface; 2, a tearing or strain of the coats of the vessel without wound; 3, fracture of a neighbouring bone.

The first is the most common, or at least the most commonly recognised† cause of traumatic aneurism. A man receives a stab or a small incised wound. It bleeds freely, and most likely in jets; but the hæmorrhage is restrained by firm pressure; the wound heals, and the man thinks himself cured. He is conscious, however, of some loss of power and some anomalous sensations

* Richet, *op. cit.* p. 324.

† If we consider the frequency with which popliteal and other surgical aneurisms are attributed to accident, and their much more frequent occurrence in persons and in situations most exposed to violence, we might be tempted to conclude that such aneurisms are usually traumatic, and due to the second of the class of causes above enumerated.

in the limb, such as cold, numbness, tingling, and a feeling of weight; and later on he discovers that a pulsating tumour exists beneath the scar of the wound.

In such a simple case it is easy to see what has happened: the artery has been penetrated by a wound which was too large to be closed by the mere efforts of nature,* but which did not cut the tube across, and did not stop the circulation. The blood has not had a very direct exit by the skin-wound, probably in consequence of the altered position which fasciæ and other membranous structures assume in deep wounds, under varying conditions of pressure, tension, &c., and therefore the bleeding has not interfered with the healing of the opening in the skin. Meanwhile, below the fascia blood has continued to exude into the cellular tissue among the muscles, forming a large diffused ecchymosis. This ecchymosis may continue for some time to increase; such, however, is not necessarily the case, since as much of the blood may be withdrawn from the cellular tissue by the action of the absorbent vessels (the veins, and possibly the lymphatics), and by reflux into the artery during its diastole, as is poured out during the systole. Sooner or later, however, the presence of the blood acts as a source of irritation, and sets up inflammation in its neighbourhood. This causes condensation, and then contraction of the areolar tissue, and so a sac is formed. By this time, probably a great part of the blood has coagulated, and so the aneurism (as it now is) contains a mixture of clotted and fluid blood, as most aneurisms do. In other cases the wounded part of the artery is believed to have yielded to the force of the circulation, and the sac is therefore formed by the tissue of the artery itself. The point is one of no practical importance. When traumatic aneurism is fully formed, the case differs in no respect from one of spontaneous aneurism, except, perhaps, in its greater proneness to cure, since the heart and arteries are probably healthy; while in spontaneous aneurism they are often diseased.

The symptoms of traumatic aneurism following an open wound are generally distinct enough. The scar of the wound will be discovered even if the history is obscure, and the pulsation and bruit are generally distinct. But it must not be forgotten, that before the sac has been formed, pulsation is

* See vol. i. pp. 744-748.

often indistinguishable, though the bruit can almost always be recognised. Such lesions as these are often incorrectly spoken of as 'aneurisms'; a term which is only applicable when the sac has formed. This is not a theoretical or pedantic verbal distinction, but a practical difference of the greatest importance. The formation of a sac is the first step towards the cure of the disease, and shows that the case is amenable to the comparatively mild and indirect measures which are adequate for the cure of an aneurism, such as pressure on the main trunk, or its ligature at a convenient spot above the tumour, instead of requiring the frequently severe and difficult operation necessary for exposing and securing the wounded part of the vessel.

Traumatic aneurisms differ in rapidity and readiness of formation according to the nature of the tissue with which the wound communicates; whether the wound be in a large cavity filled with loose cellular tissue, or a space where the blood will be bound down and disposed in extensive membraniform layers by contiguous fasciæ or tense muscles. Thus in the axilla or orbit, traumatic aneurisms of large size soon follow on injury to the main artery, or even to a comparatively small branch. The well-known case of Lieutenant Seton was an example of this fact. A wound of a branch of the external iliac, the patient being stout and the cellular interval large and loose, occasioned an extravasation of blood, which was large enough to lead to the belief that the parent vessel had been injured. In the limbs, on the contrary, the formation of aneurisms in consequence of wounds of large vessels is more rare; and when formed, they will often undergo a process of spontaneous cure by rest and simple measures. The reason for this doubtless is, that before aneurism has formed, the blood itself, bound down by tense fasciæ and strong expanded layers of muscle, exercises pressure on the wounded vessel, tending to limit the effusion and close the wound; and after the tumour has been developed, the pressure which (it must never be forgotten) the sac exerts upon its contents is materially aided by the pressure of the soft parts upon the sac.

The progress of traumatic aneurisms, therefore, is not always towards death, even if left alone; and when they are of small size they are generally easily cured. Direct pressure is peculiarly applicable; but it should be carefully regulated and adjusted, so as to avoid the danger of sloughing. Perhaps

digital pressure is the most efficient and safe, if circumstances allow us to secure the services of a relay of attendants, who will make gentle and steady pressure with their hands over the sac. Or in very small aneurisms lying against a bone, the patient may be directed to keep his finger on the pulsating part whenever he can. I have seen a small temporal aneurism, the result of the blow of a stone, thus treated with sufficient success to avoid the necessity of any other treatment. In larger and deeper tumours some form of bandage, with the intervention of an air-pad, may be necessary. Forced flexion of the limb is of course often advisable. With direct pressure may be combined the compression of the trunk leading to the swelling,* and the limb should be raised.

If these means fail, the artery must be tied. Some authors prefer in these cases the method of Anel to that of Hunter, arguing justly, that as the artery will be found healthy close to the tumour, one of the advantages which Hunter's method has over Anel's operation is lost.† This is quite true; but the general advantage of Anel's method over Hunter's, *cæteris paribus*, is very slight, since the mere fact of there being a portion of artery pervious between the ligature and the tumour hardly ever affects the progress of the case. If, therefore, the tumour be deeply seated, and it would be difficult to expose the vessel, as it leads into it, no hesitation need be entertained in trusting to the Hunterian method; while if (as is usually the case at the bend of the elbow) the tumour and the artery on which it is seated be superficial, the whole operation of opening the sac and tying both ends of the vessel offers no special difficulties, and is certain to succeed. It is therefore often adopted; and we shall see, when treating of axillary aneurism, that it has been recommended by a high authority for general use in that form of the disease. Still, the great majority of traumatic aneurisms have yielded to the proper application of pressure, and few of those which have not done so are known to have resisted the Hunterian operation. It is only in cases in which the tumour is superficially seated, and the operation therefore comparatively

* See a case of traumatic aneurism of the radial artery, cured by a combination of forced flexion of the elbow and compression of the brachial, and afterwards by extension of the arm; *Brit. Med. Journ.* 1860, p. 859.

† It will be remembered that Anel operated for a traumatic aneurism at the bend of the elbow.

easy and bloodless, that the majority of surgeons would prefer the old operation.

Traumatic aneurisms from contusion or sprain, without external wound, are too closely allied to those of spontaneous origin to call for any special notice in this place. This form of injury is nearly related to the obstruction of the arteries, which is noticed in the essay on WOUNDS OF ARTERIES, vol. i. p. 736. The difference seems to consist in the complete or partial division of the coats of the vessel; the former leading to aneurism external to the artery, the latter to the formation of a coagulum and the obliteration of its tube. It is possible, however, that some aneurisms (and amongst others many of those called spontaneous) may arise from the laceration or paralysis from injury of the middle coat of an artery, and the protrusion of the blood through the space thus left into the cellular coat, which it distends.* The point is one of anatomical rather than of practical interest.

Notwithstanding the remarkable immunity which arteries enjoy even in the most formidable injuries, it is not surprising that, as they lie so close to the bones in many situations, they should occasionally be wounded by splinters, or ruptured from sudden stretching in fractures. This accident is not common; and it usually happens in such severe injuries that amputation is necessary: some cases, however, are left, in which laceration of an artery occurs as one of the complications of a simple fracture, or of a compound fracture in which the other injuries are not very grave. In the latter case, no great difficulty can exist in deciding on the necessary treatment. If the limb is to be saved, the wound must be enlarged, and the wound of the vessel treated irrespective of the fracture. But when a large blood-vessel is wounded in a simple fracture, it is not always easy to make out in the first place whether the wounded vessel is an artery or a vein; and if the former, whether the main artery of the limb or one of its branches. In deciding between an artery and a vein, the chief guide, of course, would be the presence or absence of pulsation in the collection of blood; but then pulsation is often not perceived at first—not till the blood has become encysted, and the case therefore has changed from a wound of the vessel to a traumatic aneurism. Another important symptom is the state of the pulse below the injury; but

* See Rokitansky, *op. cit.* vol. iv. p. 299.

this may be obscured by the ecchymosis and other swelling. Again, bruit may be heard at the seat of the injury; and this, although it does not quite settle the point,* yet is perhaps the most accessible and trustworthy of all the symptoms.

Now, in such a case as this three courses are open: viz. to cut down on the seat of fracture and search for the bleeding vessel; to amputate the limb; or to leave the case to the powers of nature, aided of course by rest and suitable position.

In John Bell's *Surgery* this species of traumatic aneurism is very fully discussed; and he seems to have been of the opinion that it was always necessary, in cases not severe enough to demand amputation, to cut down and tie both ends of the vessel.† That this severe operation is, at any rate, not always necessary, is clear from the fact that four cases have occurred at the Middlesex Hospital, under the care of Mr. Moore and Mr. Mitchell Henry, in which such traumatic aneurisms have formed and have got well spontaneously. Short notes of one of these cases, which was under Mr. Moore's care, may be appended, as illustrating the subject better than a lengthened disquisition.

A woman, aged forty-two, presented herself in the middle of the day, having on the previous night fallen downstairs and injured her right arm.

* A case occurred at King's College Hospital, in which, after injury, with protrusion of one eye, a bruit was distinctly heard over that side of the head. No hesitation was experienced in coming to the conclusion that the case was one of aneurism in the orbit, and the carotid was tied. The patient died; and after death no trace of aneurism could be perceived. The cause of the sound remained obscure. The case will be hereafter referred to under the head of Orbital Aneurism.

† 'When an artery is thus lacerated, along with fracture of the bones, you have but this alternative, to cut the limb off at once, if it be very desperately wounded, or to try to save it, by making incisions and tying the artery. The fracture is already complicated with aneurism, and you are under the dangerous necessity of converting this complicated aneurism into a compound fracture. You apply your tourniquet, make a long and deep incision, turn out the coagula of blood with your fingers, cleanse the sac with sponges, search for the artery, and tie it up above and below where it is torn. You wash out the blood from the sac with syringes and sponges, for while it lies betwixt the bones they cannot unite; what blood you are forced to leave melts down into bad matter and flows off; the deeper parts of the wound gradually digest, granulate, and fill up with soft flesh; and when the continuity of the parts is thus restored, the new bone or callus begins to form. Such is the activity of a wounded artery in forming its aneurism and destroying the surrounding parts, and so complicated is the disorder when a wounded artery is added to a fractured bone, that unless these operations are performed early, the limb is inevitably lost.'—John Bell's *Surgery*, Charles Bell's edit. 1826, vol. iv. p. 404.

The whole of the hand and fore-arm and part of the upper-arm were tensely swollen, and covered with bullæ of various but principally small size. Serum mixed with blood filled the bullæ. It was easy to make out a fracture of the olecranon; but it was impossible to perceive any fracture of the humerus, and the bones of the fore-arm appeared to be in place. She refused to come into the hospital, but was admitted next day. The swelling was then larger, and the vesications more extensive. There was an aneurismal pulsation in front of the elbow, strong and expanding, but deeply seated. The impulse extended halfway up the inner side of the arm, and more than halfway down the whole palmar surface of the fore-arm. A distinct bruit was heard with the stethoscope in front of the elbow. The two arteries at the wrist beat so forward and so forcibly, and appeared so much larger than those of the other side, as to give the idea that they had been raised by extravasated blood, and that the pulsation was communicated to the distended sheaths of the vessels. The skin of the hand was dusky from congestion; and when the colour was driven away by pressure, it returned very slowly, showing the embarrassed condition of the circulation. The limb was everywhere warm, however, and there was no sign of impending gangrene. A consultation was held, at which various opinions were expressed as to the appropriate treatment; but it was agreed that there could be no doubt that some large artery, possibly the brachial, was wounded. It was ultimately decided to watch the case. In the evening the swelling was found not to have increased, and the hand was certainly less tense. A rounded swelling was found near the armpit, in the neighbourhood of the brachial artery, which appeared to be the end of the clot of blood. On the following day (the third from the accident) pulsation had ceased in all other parts, and was perceptible only in front of the elbow, over a space about as large as a half-crown, and not strong. Next day the aneurismal pulsation finally disappeared, and the swelling afterwards gradually subsided. When the subsidence was sufficient, fracture of the lower end of the humerus was detected. The case did well.

Of the other three cases, one, under Mr. Henry's care, was a wound of the posterior tibial artery, in a boy who suffered from simple fracture of the leg. The diagnosis rested upon the absence of pulse in the artery, and the presence of bruit, together with peculiar restlessness of the limb. The fracture healed slowly (in about two months), and the above symptoms gradually subsided; but the pulse did not return in the affected artery. In the third case (Mr. Moore's patient), one of simple fracture of the femur in a man aged thirty-five, there was extensive swelling, together with arterial bruit in some artery—not the femoral—which could be felt below the seat of injury. Here also the bruit and swelling disappeared with rest, and the fracture united in three months. The fourth case, also under Mr. Moore's care, was, like the second, a wound of one of the tibial arteries in fracture of the leg.

It will be noticed that the majority of these cases were merely wounds of the artery, and not aneurisms in the strict sense of that term: since they recovered without the formation of any aneurismal sac.* This fact seems to testify, even more strongly

* To these cases of lesion of arteries in fracture may be added a case mentioned by Mr. Skey, in a discussion at the Medical and Chirurgical Society, on

than the mere occurrence of spontaneous cure, to the decided tendency to recovery manifested by wounds of healthy arteries when uncomplicated by external injury.* But if an aneurismal sac should form, its formation, far from being an unfavourable feature in the progress of the case, is part of the process of cure. It seems abundantly clear, therefore, that surgical interference in these cases can only be justified by the presence of alarming symptoms; and that, by the aid of simple position, and perhaps in appropriate cases light and even compression, a great number of arteries wounded in fracture will heal.

The clot sometimes softens, and suppuration occurs; and this again may lead to the spontaneous cure of the injury. An interesting instance of this spontaneous ejection of the clot may be found in Ormerod's *Clinical Collections*, p. 143, after rupture of the femoral artery in a child, the patient recovering, with only the loss of two toes by gangrene; but the limb was useless.

There are, however, no doubt, cases in which things do not proceed so favourably; and this unfavourable course tends in one of two directions—either that no aneurism forms, but the extravasation of blood increases, and thus the circulation is so far disturbed that gangrene is either commencing or appears imminent; or that an aneurism has formed, and its increase calls for some operation to check it. If no aneurismal sac has been formed, and the extravasation of blood is increasing, gangrene will soon commence. The only way to prevent it would be to cut down, as recommended by John Bell, upon the wounded vessel; but the opportunity will rarely occur. When gangrene has absolutely set in, it appears theoretically possible that a similar practice might be occasionally advisable; but in all the cases of which I have knowledge, amputation or death has been the alternative. Still, the relief to the circulation afforded by the removal of the extravasated blood might, in some rare cases of

a paper by Mr. Syme (see *infr.* Axillary Aneurism). The patient, a woman, was supposed to have met with a dislocation of the shoulder, which was thought to have been reduced. A very large aneurism formed in the axilla. The tumour was laid open. Great hæmorrhage followed; but this was soon checked, and both ends of the vessel were tied. The woman died. It was found that the artery had been wounded by the sharp ends of a fracture of the neck of the humerus.

* I would remind the reader of the many instances in which arteries have been wounded in subcutaneous section of tendons, and the rarity of consequent mischief.

injury to the upper extremity, determine the surgeon to cut down upon the seat of injury, as a last effort to save a portion at any rate of a hand in which gangrene had absolutely commenced. This is a matter which would depend entirely upon individual judgment, based upon the symptoms of the case in hand. In the second case, that in which an aneurism has formed and is advancing, the treatment differs in no respect from that of aneurism in other circumstances and from other causes.

The two cases related by Dupuytren* are well known: one occurred in his own practice; one under the care of Delpech. In both, some artery at the back of the leg (the popliteal, or one of its branches near the division) had been torn in a comminuted fracture of the bones of the leg; a pulsating swelling formed in the ham; and the surgeon, unwilling to amputate the thigh, fearing to lay open so large a cavity and inflict such extensive injury upon the seat of fracture, and being unaware of the reparative power of nature in such cases, cut down on the femoral artery and tied it. Both patients recovered, without a bad symptom.

These cases are interesting, and will repay perusal. They bear a striking resemblance to Mr. Moore's case quoted above (p. 519); and it seems very probable that, if they had been similarly treated, they might have undergone a spontaneous cure, in the same manner as that and the other cases there referred to did. In neither of the cases related in the *Leçons orales* was there an aneurism, properly speaking, since sufficient time had not elapsed for the formation of a sac; but the clearness of the pulsation renders it probable that the ecchymosis was tending to become limited, and that a sac would soon form; and this appears to furnish an additional reason for waiting and watching the result. When aneurism has formed, it is a sign that the cellular tissue is contracting upon the blood. This is very likely to lead to deposit of laminated coagulum in the sac. At any rate, it is highly improbable that the aneurism will begin to increase rapidly, since the patient is of course at rest and the limb in an appropriate position. Should it, however, increase, compression of the artery above will be the method most probably indicated, perhaps with gentle compression on the sac, if the fracture is sufficiently consolidated. If the fracture be firmly united, it may even be advisable to resort to forcible flexion. In cases, however, where a main artery is wounded, as well as in those where it is tied, the fracture unites very slowly. This may be noticed in the cases from Middlesex

* 'Sur les Anévrismes qui compliquent les Fractures,' &c., *Leçons orales*, tome ii. pp. 521, &c. Paris, 1839.

Hospital, quoted above, and has been observed by Dupuytren and others; so that the treatment of traumatic aneurism from fracture, if it increase while the patient is lying in bed, will be by compression or ligature of the main trunk; and in cases so far resembling Mr. Spence's, quoted on p. 500, that the aneurism has apparently consolidated during the repose necessitated by the fracture, but recurs on the patient resuming his active avocations, the treatment there pursued (that of forcible flexion) will very probably be as successful as it was in that case, should the situation of the tumour render it applicable.

Aneurisms the result of fracture are not confined only to the arteries of the limbs, but may form in any part where an artery lies sufficiently near to a bone to be involved in the injury. Thus Mr. Busk and Mr. Curling have each put upon record a case in which a traumatic aneurism formed upon the ophthalmic artery as a consequence of fracture of the base of the skull.* In both cases the carotid artery was tied, and with complete success. (See below on Orbital Aneurism.)

Rupture of arteries.—The complete subcutaneous rupture of an artery from a blow, strain, or wrench, and the consequent extravasation of blood into the cellular membrane, is the form of injury which is usually, though incorrectly, called a 'diffused traumatic aneurism.' It should be called what it is, viz., 'rupture' or 'laceration' of the vessel. The injury is more commonly seen in the popliteal than in any other vessel, and next in the axillary, from obvious causes. The symptoms are, failure of the pulse below the seat of injury, great swelling of the limb from effusion of blood beneath the fascia, and remarkable loss of temperature. Pulsation cannot be detected unless the collection of blood is becoming encysted (*i.e.* the case is passing on to the formation of aneurism)—at least this has been the case in all the instances of this injury which I have seen. Bruit can usually be heard, but this symptom is variable. I regard the loss of temperature as a most valuable sign of the injury. In some cases the rupture may be at first only partial, and then some pulsation may be detected in the vessels below the injured part.†

* *Med.-Chir. Trans.* vols. xxii. xxxvii. See also the first of Mr. Nunneley's cases in vol. xlii.

† See a case under Mr. Brodhurst's care reported in the *Path. Trans.* vol. xvii. p. 74. Here the rupture seems to have been rendered almost complete by the exertion of taking a long walk. See also a case under Mr. Cæsar Hawkins' care, in *Poland*, *op. cit.* p. 24.

Mr. Poland* believes that in such cases pulsation is more likely to be found in the collection of extravasated blood than when the artery is completely ruptured.

The treatment of this injury must depend on the vessel involved. When the symptoms of rupture of the popliteal artery have been well marked, I have never seen a case in which ultimately amputation or death has not followed, nor can I find any recorded case which is to my mind satisfactory. Hence I think the best course is to amputate at once, when the loss of pulsation and the fall of temperature indicate plainly that the artery is completely torn across. In smaller arteries, and in those of the upper extremity, even as large a vessel as the axillary, the proper course is to cut down upon and secure the vessel. When partial rupture is suspected, a trial may be given to compression of the trunk leading to the injured part.

The accompanying vein is often also ruptured, especially when the artery is torn completely across. I am not aware that any symptoms exist by which this complication can be distinctly recognised; but its known frequency constitutes an additional motive for amputation in such cases. Sometimes the popliteal nerve has also been torn.

ARTERIO-VENOUS ANEURISM.

Under this title are included two forms of aneurismal dilatation of an artery, communicating with a vein, known respectively as varicose aneurism and aneurismal varix.†

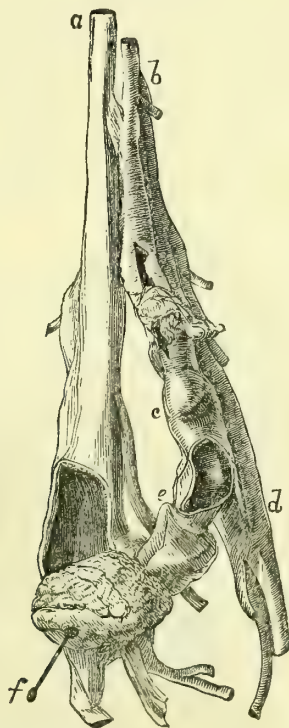
Varicose aneurism consists of a circumscribed consecutive aneurism, which communicates with the artery on one side and the vein on the other. The vein is always tortuous and dilated, sometimes to an enormous extent. In aneurismal varix there is no aneurismal sac. Adhesion has occurred between the artery and the vein at the point at which they communicate; and the blood is projected directly from the artery into the vein at each pulsation. Here also the veins connected with the diseased part are greatly dilated, and the embarrassment of the circulation thus produced is the chief symptom of the affection.

* 'On Rupture of the Popliteal Artery,' &c., from *Guy's Hospital Reports*, p. 32.

† William Hunter was the first to describe arterio-venous aneurism accurately; and he also pointed out the difference between an aneurismal varix and a varicose aneurism, though he did not use those terms. See South's *Chelius*, vol. ii. p. 272.

The usual condition of a varicose aneurism is shown in the accompanying figure, drawn from a preparation in the Museum of University College. Another interesting peculiarity is also to be noticed in this preparation—viz. that there is a high division of the brachial artery, and that therefore a ligature placed upon what was supposed to be the brachial artery might have failed to cure the

FIG. 163.



Drawing, from a preparation by Mr. Liston,* of varicose aneurism at the bend of the elbow, in the Museum of University College, London. There is a high division of the brachial. The artery on which the aneurism is seated is the radial, which communicates very freely with the ulnar by a large transverse branch just below the sac. A probe has been passed from an opening in the skin (probably the puncture of the phlebotomy) through the vein and aneurism into the artery.—a. The basilic vein. b. The brachial artery dividing above the usual level. c. The radial, on which the aneurism is seated, and which has been tied a little above this point. d. The ulnar anastomosing freely with the radial just below the aneurism. e. The arterio-venous aneurism, constricted at this part by the bicipital fascia. f. The probe passed through the puncture, made in phlebotomy, and from which hæmorrhage occurred during life. It is not known whether the patient died of this hæmorrhage, or whether the arm was amputated. (I am indebted to Mr. Marshall for the particulars stated above.)

* I have not been able to find any reference to this case in Mr. Liston's published works, although there is an allusion to the possibility of failing to cure aneurism by ligature of the brachial, in consequence of high division, in vol. ii. p. 307 of his *Elements of Surgery*, ed. 1832.

Less frequently, arterio-venous aneurisms arise in the same way on the limbs, and on other parts of the trunk. Sometimes these occur long after the infliction of a wound which had affected the artery, but which had been perhaps almost forgotten.

Thus Rokitsansky observed an axillary aneurism of this kind thirty years after a shot had taken effect on the spot. Roux * relates a case in which arterio-venous aneurism at the elbow formed four years after venesection; and Monneret † has described an aneurismal communication between the femoral artery and the vein, said to have arisen twelve years after injury from a shot. This was also the case with Mr. Beaumont's patient, p. 526.

Again, spontaneous arterio-venous aneurism has been described by Bransby Cooper, ‡ by Perry, § and Porter, || affecting the femoral vessels in cases where the aneurism could not be traced to any other cause than primitive disease and thinning of the coats of the vessels. In the highly interesting case related by Mr. Perry there was more than one communication.

It is usually a main artery, and its collateral vein which are thus affected; and it may be readily understood that, from their close contiguity and often superficial position, these would be more likely to become the subjects of this diseased connection; but the elaborate investigation of M. Follin and Charnal, ¶ and the cases of Puydebat** and Pancoast†† have shown that deeply-seated veins, as well as superficial veins, may be thus affected.

In the case of M. Follin, a communication between the brachial artery and a deep vein was diagnosed during life, and subsequently proved by the dissection of M. Charnal. Schottin ‡‡ has seen a similar connection between the radial artery and the cephalic vein. Moore §§ relates a case in which an arterio-venous aneurism was found in the trunk of the popliteal nerve, as a result of a blow on the part, which appears to have produced rupture of a small artery and its companion vein in the substance of the nerve.

These two forms of arterio-venous aneurism have some symptoms in common due to the communication between the artery and vein. The most characteristic is a vibratory thrill, which results from the impulsion of the arterial blood into the patent aperture of the vein, there to mingle with the venous current. The greater tension of the arterial than the venous wall, and the greater force of the arterial flow of blood, causes a continuous injection of arterial blood into the venous tumour; but the pulsation of the artery produces a synchronous impulse in the

* *Bulletin de l'Acad. de Méd. Paris*, 1849. † *Bulletin de Méd. et de Chir.* 1852.

‡ *Guy's Hospital Reports*, vol. v. § *Med.-Chir Trans.* vol. xx.

|| *Todd's Cyclop. Arteries*, p. 242. ¶ *Bulletin de la Soc. de Chir.* vols. iii. v.

** *Bulletin de la Soc. Anat.* 1834. †† Fergusson's *Handbook of Surgery*. 1852.

‡‡ Schottin, *Merkwürdiger Fall einer aneurismatischen Venengeschwulst*. Altenburg, 1825.

§§ *Med.-Chir. Trans.* xlix. p. 29.

flow of the blood through the tumour. Hence the peculiar vibratory or pulsatory character of the thrill, which is otherwise continuous. The ear detects a harsh, buzzing sound, which has been variously compared to that of a saw, a file, a bee, the hissing of burning metal plunged into cold water, and similar noises. This sound too is continuous, although momentarily increased during pulsation. It grows fainter on being propagated along the artery, and at some distance from the aneurism in which it arises it seems intermittent, the louder pulsatory sound only being then heard. This sound may be so loud as to be audible by a person standing near the patient; but that is exceptional. It may, however, always be distinctly heard with the stethoscope, or by the naked ear; and its continuous character sharply distinguishes an arterio-venous from a pure arterial aneurism. Considerable dilatation of the veins, a third symptom, is consequent upon the obstruction of the venous circulation by the entrance of arterial blood flowing in an opposite direction, and upon the general increase thus made to the quantity of blood which the vein must carry towards the heart. The extent of this dilatation varies according to the size and importance of the vessels affected. It is most marked in the lower limbs, where gravity aids in increasing the obstruction and consequent tendency to varicosity. Here the veins have been described like knotted ropes beneath the skin by Porter, Perry, Laugier, and others. In Mr. Moore's case, where the temporal vessels were affected, the veins were enormously dilated, and pulsated so strongly as entirely to simulate arteries during the operation performed.*

This pulsation of the veins is a fourth important symptom which deserves to be borne in mind; because the surgeon may be, and has been, induced by it to place a ligature round one of the veins, thinking it to be an artery. William Hunter noticed that the arteries below the point of communication beat more feebly than in the healthy body; and naturally, since a part of their ordinary supply of blood is directed into the vein. But this symptom is not always observed. The temperature of the part, and the growth of hair on the skin, are some times augmented below the communication. In old-standing cases, a remarkable condition of dilatation is observed in the arteries above the varix. They become enlarged, tortuous, and thinned

* *Med.-Chir. Trans.* vol. xli. p. 1.

occurred as the result of profuse hæmorrhage from the nose. In such cases, of course, only the Hunterian ligature is possible; but where the artery is more accessible, it is obviously more desirable to apply a ligature above and below the diseased communication.

The treatment of varicose aneurism is somewhat different in kind; for here a sac intervenes between the artery and the vein, but it is similar in principle. Here also direct and indirect compression have been largely tried. In general such trials have not been very successful. M. Nélaton, however, has succeeded four times in converting a varicose aneurism at the bend of the elbow into a simple arterial aneurism by direct pressure. Cure was then in all cases effected either by ligature, or compression of the brachial artery.* Digital compression might be employed in the simpler cases, not without hope of cure.

Should it be necessary to apply the ligature, it is requisite to reject the method of Hunter in favour of the ancient proceeding. The most simple plan is to lay open the sac, trace it into the artery, and having exposed the aperture in the artery, for which purpose it is commonly necessary to divide the sac transversely on a director, then to apply a ligature above and below the arterial opening. This method is more simple than that which has been employed by Roux and Fergusson, who have endeavoured to isolate the artery, and tie it above and below without opening the sac at all.† This is the more difficult, that the artery below its point of communication is small, and surrounded by veins dilated and closely packed. On the other hand, it is free from the objection attaching to the plan first described, arising out of the danger of putting two ligatures close to the sac, and at a point where it is surrounded by dilated veins. In any case the operation is peculiarly liable to one of two secondary accidents, hæmorrhage and gangrene; hæmorrhage from the part of the artery above the sac where it is dilated, thinned, and gives rise to numerous collateral branches; and gangrene of the limb below, which perhaps already, before the operation, was cold, benumbed, and œdematous. The injection of a weak solution of perchloride of iron has been

* *Journ. de Méd. et Chir. prat.* 1862, p. 155.

† This operation was recently performed successfully by Prof. Spence in a case of arterio-venous aneurism of the femoral artery. (*Edin. Med. Journ.* July 1869.)

employed by Serres and Jobert,* Velpeau,† and Vallette,‡ twice with perfect success; once producing suppuration of the sac, followed by cure, and once, by M. Velpeau, ineffectually. These facts are in favour of this method of treatment; and as the safeguards against the accident of suppuration are more carefully studied, this plan may recommend itself still more strongly to the surgeon.

Galvano-puncture has been employed by Bosse and Capeletti. In Bosse's case two steel needles, connected with thirty-two pairs of galvanic plates, were introduced into the aneurismal tumour, and retained there for eighteen minutes. The cure was completed within ten days. In Capeletti's case the needle was introduced twice; suppuration followed and ultimately a cure. M. Debout has also recorded a successful case.§

There will be cases in which an expectant treatment will be most advisable, and others in which amputation might be the only available measure.

Thus a case is reported in the *Journal de Méd. et Chir. pratique* for 1862, p. 155, under M. Nélaton's care, in which a man was suffering from an arterio-venous aneurism of considerable size in the ham, the result of a punctured wound of the popliteal artery. M. Nélaton recommended that no operative measures should be adopted, believing that the aperture of the aneurism into the vein was sufficiently free to render the bursting of the tumour improbable; and he remarked that the only efficient measure for the radical cure of the disease would be the old operation for aneurism, and this under the circumstances he held to be so difficult and dangerous, that if driven to operate, he should prefer amputation.

CIRSOID ANEURISM, AND ANEURISM BY ANASTOMOSIS.

By cirroid aneurism is understood a form of disease which consists in a simultaneous elongation and dilatation of an artery. The structure of its wall exhibits in the beginning no alteration, although the coats become thinned during the progress of the enlargement. It will be observed that this lesion is not strictly included in the terms of the definition which was given of aneurism, and recent authors have agreed that this disease is

* *Bulletin de l'Acad. de Méd.* 1854.

† 'Traitement de l'anévrisme artério-veineux,' *Bulletin de l'Académie de Médecine*, 1854.

‡ *Acad. de Méd. Paris*, May 23, 1859.

§ See Wernher, iii. 821.; Ciniselli, *sulla Elettropuntura nella cura degli Aneurismi*: Cremona, 1856. Debout, *Bulletin de Thérapeutique*, 1847, p. 123.

improperly denominated aneurism. But it seems practically most convenient to describe it here.

It is especially the middle coat of the artery which is affected when the process of thinning commences. This structure becomes pale, soft, and thin, so that the arteries look like thin veins. The dilatation is commonly equal throughout the circumference of the artery; but in the more severe cases the artery is greatly dilated, and presents unequal saccular pouches, which are, in fact, so many true aneurisms, projecting usually

FIG. 165.



Cirroid aneurism of the scalp. (From a drawing in the Museum of St. George's Hospital.)

towards the surface of the skin. As the artery elongates, it becomes tortuous and serpentine; sometimes even spiral. The disease is rarely circumscribed, but attacks commonly several trunks and their branches. M. Broca, however, has described a case of perfectly circumscribed cirroid aneurism of the scalp, treated successfully by the injection of perchloride of iron.* It may occur in the arteries of the extremity, and Cruveilhier has

* *Bulletin de la Société de Chirurgie de Paris*, 1859.

reported a remarkable case of cirroid aneurism of the external iliac artery.* But it is more especially frequent in the arteries of the scalp, and in this situation more instances have been recorded than in all the other parts of the body taken together. Originating usually in one of the arteries of the scalp, it extends itself to the branches of the other side of the head, and may implicate the connected vessels to a variable extent. On the one hand, it may pass into the capillaries, widely dilating them, and affecting even the terminal veins in its march; or on the other, but in a smaller degree, it may affect by retrogression the larger branches from which the arteries of the scalp arise, passing even into the carotids. It is thus that it changes somewhat its anatomical characters. The venous capillaries and trunks become affected by the extension of the disease, and the arterial network becoming highly and morbidly developed, this form is known by the name of *aneurism by anastomosis*. The pathological condition and the principles of treatment are essentially the same; but when the disease is seated in the larger arterial trunks, it is commonly known as cirroid aneurism; when it extends into the network of capillaries, it is known as aneurism by anastomosis, or racemose aneurism. It attacks most frequently the superficial temporal, the posterior auricular, and the occipital arteries. Commonly the surrounding tissues suffer but little injury; but sometimes the subcutaneous cellular tissue may be atrophied, and the skin dangerously thinned; at other times the soft parts may be thickened and indurated; sometimes the bones are grooved, or even perforated.

M. Gosselin† has endeavoured to subdivide cirroid aneurisms into three classes: arterial varix, when large arteries are affected (as in Cruveilhier's case); cirroid arterial tumour, when the smaller arteries are affected, forming a circumscribed lobulated pulsatile tumour; and aneurism by anastomosis, when the capillaries and skin are involved. The distinction is a real one in many cases, and useful to recollect, having an important bearing on practice; but the three forms are too much mixed together to enable us to accept it as a classification of the disease. The second class are those in which coagulating injections, according to M. Gosselin, are likely to succeed; and

* See also Cocteau, 'Sur les Varices artérielles des membres,' *Arch. gén. de Méd.* 1865, p. 666.

† *Arch. gén. de Méd.* 1867.

I would add that in the third class galvano-caustic or extirpation are the methods usually indicated.

The causes which give rise to cirroid aneurism are not apparent. Occasionally its origin has been referred to a blow, or to an injury of a congenital erectile tumour; more often no cause can be assigned, and it is not evident why the scalp should be the chosen seat of this disease. It may be noticed here that the majority of cases occur in persons whose age varies from fifteen to thirty. The diagnosis of the disease can hardly be a source of difficulty, for the serpentine and pulsating character of the tumour afford a distinguishing sign. The manner of diagnosing this affection from varicose aneurism or aneurismal varix has been mentioned in the last section. But where it is associated with dilatation of the veins, some difficulty may arise in distinguishing it from the so-called erectile tumour, or teleangeiectasis, from which it is, however, still distinguished by its pulsations. Such cases have been recorded by Pelletan,* by Dupuytren,† and others.

The treatment of this disease commonly offers great difficulties and many risks. The frequency with which direct failure has followed various procedures, the yet greater frequency of relapse, and the occasionally fatal termination of operations which have been undertaken, are reasons for caution in dealing with this disease. Unless there is reason to fear that by its extension or by its severity it may prove fatal to life, it is commonly the more prudent course to abstain from operative interference. Cirroid anastomosing aneurism is not always a source of imminent danger, and it may exist for many years without any other evil effect than that of inconvenience; and, indeed, in some of the least unfortunate cases it has so continued after various operations. Even where extensive and severe, it cannot always be treated with advantage.

The simplest method of treatment is by compression; but this is also the most ineffectual. I am not acquainted with any case in which it has proved successful, although trials have been recorded by Dupuytren, Robert,‡ and Brodie.§ If palliation be desired, little more can be done than to provide a metal covering to protect the affected part, where the locality admits of such a provision. The ligature of the branches directly leading to the affected part has been often tried; but this also

* Pelletan, *Clinique chirurgicale*, vol. ii. p. 59. Paris, 1810.

† Dupuytren, *Leçons orales*, vol. v. p. 43. Paris, 1839.

‡ *Gaz. des Hôpitaux*, 1851, p. 130.

§ *Lancet*, 1828-9, vol. ii. p. 559.

has rarely succeeded. In a case in which Breschet tied the temporal artery in a girl eighteen years of age, for a severe form of the disease, death from pyæmia took place on the fourteenth day,* the ligature having been carried through and not round the vessel. Maclachlan tied the temporal artery, also without success, and followed it by ligature of the common carotid.† In a patient of Dupuytren's, both the temporal and occipital arteries had been tied unsuccessfully.‡ Gibson in a similar case tied the main branches of the temporal and occipital artery ineffectually.§ The records of the results of this proceeding are not in its favour.

The ligature of the external carotid has been performed for a cirroid aneurism of the scalp by Maisonneuve.||

He tied the right external carotid for a cirroid aneurism of the right temporal artery occurring in a woman thirty years of age two months after a blow. The patient was suffering acute pain, and the disease beginning rapidly to extend, besides tying the external carotid, he put a ligature also round the superior thyroid artery. Pulsation ceased, the tumour diminished, and all went well for the first three weeks. Secondary hæmorrhage followed the separation of the ligature, and Maisonneuve tied successively the common and the internal carotid arteries. The latter operation was followed by hemiplegia, and, after three days, by death. The brain substance of the right hemisphere was found to be deliquescent. This case had, therefore, a very unfortunate termination; but it is worthy of especial note, because it is, perhaps, the only recorded instance in which the external carotid artery has been tied for cirroid aneurism of the scalp, and because that proceeding would appear on anatomical grounds to be the best calculated to arrest the circulation in the part affected.

Prof. Bruns,¶ who has given great attention to this subject, points out that the ligature of the external carotids is the proceeding best calculated to cut off the supply of blood to aneurisms of the scalp. He urges that the external carotids of both sides should be ligatured in such cases, and certainly where it is necessary, from repeated local hæmorrhages or threatened rupture, to employ serious surgical interference, the ligature of one, and still more of the two external carotids, would best effect the diminution in the supply of blood to the arteries in the scalp; for then only the supra-orbital and frontal branches of the internal carotid would remain capable of supplying blood

* Breschet, *Mémoires chirurgicaux sur les différentes espèces d'Anévrismes*, p. 54. Paris, 1834.

† *Lancet*, 1827-8, vol. i. p. 773.

‡ *Leçons orales*, loc. cit.

§ *Institutes and Practice of Surgery*, vol. i. Philadelphia, 1835.

|| *Bulletin de la Société de Médecine de Paris*, 1851, vol. i. p. 400.

¶ *Hanbuch d. pract. Chir.* i. p. 161. Tübingen, 1854.

in this direction; and unless the disease were seated in the forehead, their influence need hardly be feared. Posteriorly the blood would reach the scalp only through the anastomosis of the occipital arteries with the ascending cervical branches of the subclavian and the muscular twigs of the vertebral artery; whilst in front some further assistance would be given by the connection of the inferior thyroid branch of the subclavian with the superior thyroid branch of the carotid. This suggestion might not be unworthy of the consideration of surgeons in future cases.

Judging from anatomical data, the ligature of the common carotid artery, while it is pregnant with greater dangers, offers fewer advantages than the application of the same procedure to the external carotids. It has, however, been practised in at least fifteen cases, but its successes have been few. The only superiority which it possesses over the ligature of the external carotid is by shutting off the supply through the branches of the ophthalmic artery; but the large and numerous anastomoses of the carotid of the opposite side continue to supply blood, and even where a temporary improvement has followed the operation, speedy relapse has occurred, probably from this cause. Again, the disturbance of the cerebral circulation by ligature of the common carotid has of course its own peculiar dangers. So that out of eighteen cases in which the operation was performed, death occurred under the knife in three instances, and four others terminated fatally; in five an early relapse followed the first improvement; in the tenth case no final report has been given; and in only two is it stated that there was lasting improvement. Instances in which the common carotid has been tied for this disease are recorded by Robert,* Dupuytren,† Kühn,‡ Bush,§ Wardrop,|| MacLachlan,¶ Maisonneuve,**

* *Gaz. des Hôpitaux*, 1851, pp. 130, 128, and *Bulletin de l'Acad. de Méd.* vol. xvi.

† In this case of Dupuytren the right common carotid was tied in 1809. The tumour remained stationary till 1848, when it again became very much ulcerated, and gave rise to frightful hæmorrhage. He came under the care of M. Robert at the Hospital Beaujon in 1857, when the left carotid was also tied, with temporary success.

‡ Kühn, *Opusc. Academica*, editio Claras; Leipsiæ, 1842, p. 51.

§ *New York Journal*, &c. 1819, vol. i.

|| *Lancet*, 1827-8, vol. i. p. 24.

¶ *Glasgow Medical Journal*, 1827.

** *Supra cit.*

Walther,* Mussey,† Warren,‡ Hersche, Kerr, Zeiss, Arend.§ Travers junior,|| Mott, Wood,¶ and Critchett.** A proceeding which has proved so fatal in the hands of surgeons so eminent must be regarded with great distrust. It is certain that in very many cases the dangers of this operation must be greater than those of the disease itself; and when those perils are surmounted, its success must still remain a contingency, which in the past has only three times been nominally realised in eighteen cases. Attempts have been made to cure cirsoid aneurisms by a method conceived after the old proceeding of Antyllus for true aneurisms. It has been proposed to lay open the tumour by a stroke of the scalpel, to stuff the arterial wound with lint, arrest hæmorrhage by firm compression, and trust to the inflammatory exudation thus excited for the obliteration of the arterial channel. It is obvious that this method could only be applied to those cases of circumscribed cirsoid aneurism in which the artery forms a limited tumour by its convolutions, and to cases of limited aneurism by anastomosis. Gräfe first employed this proceeding for a cirsoid aneurismal tumour of the forehead in a boy aged ten.†† He divided it across with a strong scalpel, stuffed the wound quickly with agaric and sponge, and firmly strapped and bandaged the whole. On the following day, as the pressure was slightly relaxed, the wound granulated, and when the parts healed there was no pulsation in any part of the solidified tumour. Bell,‡‡ Arnott, and Lawrence,§§ have succeeded also in curing aneurism by anastomosis, by incising the soft parts, and promoting supuration in the tumour, maintaining meantime compression. It would not be reasonable to expect that the obliteration of a single large artery in a state of cirsoid dilatation could commonly be satisfactorily effected in this way; not only the fear of secondary hæmorrhage presents itself, but we know that arteries are but little prone to adhesive inflammation, and that arterial blood is quick to find outlets and make channels for itself. In a case of

* *Gräfe und Walther's Journal*, vol. v.

† *Amer. Journal of Med. Sciences*, 1830. ‡ *Practical Remarks on Tumours*.

§ Quoted by Wernher, *Handb. der Chir.* vol. iii. p. 806. Giessen, 1855.

|| *Lancet*, vol. ii. 1857, pp. 497, 627; vol. i. 1858, pp. 75, 399 (see also below, on p. 541).

¶ *New York Journal of Medicine*, 1857.

** *Statistical Reports Med. Times and Gaz.* vols. xxx. and xxxi.

†† *Gräfe und Walther's Journal*, vol. xviii. p. 20.

‡‡ Bell, *Principles of Surgery.* §§ Lawrence, *Med.-Chir. Trans.* vol. ix.

truly cirroid aneurism this proceeding will almost certainly fail.

A more efficient means of destroying circumscribed cirroid aneurism is to be found in extirpation en masse by the knife or by ligature. The latter method was employed by Sir B. Brodie with only temporary success in treating a cirroid and anastomosing arterial tumour of the head of the size of a walnut, which had the characteristic feeling as of a convolution of meandering vessels with strong pulsations. The tumour was transfixed crosswise, and strangulated by four threads in as many parts. The cure was reported at the time to be complete.* But Mr. Prescott Hewett mentioned in a lecture at the Royal College of Surgeons the fact that the disease recurred in this case, and that the patient died some years afterwards, death being attributed to 'nervous debility.'

Excision of the tumour by the knife has been several times accomplished, and has yielded cures in cases of great severity.

Mussey's† case is one of the most remarkable on record. The patient, a young man aged twenty, had on the top of his head a cirroid aneurism of great size. All the arteries of one side of the head were enormously dilated, and when the head was shaved, twenty arteries of the size of a goose-quill were felt which led to the tumour. Ligature of the left common carotid failed to cure, and the ligature of the right common carotid twelve days later also effected only a temporary improvement. Extirpation was resolved upon; two semilunar incisions being made around the tumour, which was then peeled off from the pericranium. These incisions were made gradually; the arteries wounded being tied at each half-inch: this occupied more than an hour, and forty ligatures were required. In spite of all precautions, there was a great quantity of blood lost, and the patient fell into syncope; the wound, however, granulated, and the patient is stated to have recovered completely.

Gräfe,‡ Gibson,§ Weitzer||, Busch, Warren, and Guéniot¶ have also employed this method. Mr. Hart employed it successfully; freezing the tumour and cutting wide of it, so that very little blood was lost. The difficulties of this method, however,

* *Med.-Chir. Trans.* 1829, vol. xv.

† *Loc. cit.*

‡ *Gräfe und Walther's Journal*, vol. xiv. p. 639.

§ *Op. cit.*

|| *Deutsche Klinik*, 1850.

¶ *Gaz. des Hôp.* 1868, p. 153. This author remarks that the fact of the incision being carried a little within the tumour, so as to leave a few pieces of the morbid tissue, is rather advantageous; the tissue is supple and the arteries are easily tied in it; it speedily melts away as the wound suppurates.

have proved very great, and its danger is considerable. The hæmorrhage in some of these cases was excessive. But the issue of all the recorded cases in which it has been undertaken has been successful, and excision by the knife has as yet proved a most rapid, safe, and successful means of treatment. It is obvious that great skill and caution are required to carry it into effect, and in very extensive developments of the disease it will be inapplicable. It might commonly be prudent to preface the extirpation of the tumour by the ligature of the main trunks which feed it; when practising the incisions around the tumour, the knife should travel slowly, and the arteries are to be tied as they are divided. It was by the combination of well-timed caution and necessary boldness that some of these formidable operations have been brought to a successful issue.

Cirsoid aneurisms have also been treated by galvano-puncture, galvano-caustic, and coagulating injection.

In a case under Nélaton's care, treated by galvano-puncture, the patient was a woman aged twenty, having a tumour on the forehead, made up of convoluted vessels, the coils of which could be clearly distinguished by the touch; it had arisen two or three months before, after a blow. Two needles, connected with a Bunsen's pile of thirty couples, were passed into the tumour where the pulsations were the most violent, and the current was transmitted through them for ten minutes. Next day, consolidation was found to have taken place where the positive needle had entered, and after some further sittings the whole tumour had become a hard mass, which was gradually absorbed.*

The case of aneurism by anastomosis of the ear and scalp, in which (as mentioned above) the common carotid was tied with a fatal result by Mr. Travers jun., had been previously under the care of Mr. Cutler and Mr. Prescott Hewett at St. George's Hospital. It was then treated by a combination of the electric cautery, styptics, and ligature of portions of the tumour. The result was very satisfactory: all bleeding ceased, the tumour in great part sloughed away, the ulceration healed, and the greater part of the hypertrophied vessels resumed their natural appearance. The patient remained free from dangerous symptoms during an interval of three years, when the tumour gradually returned and bleeding recommenced. Mr. Travers was sent for to see him in the country, and tied the common carotid artery; but the patient died of hæmorrhage, which commenced while the ligature was still on the vessel; a striking proof of the inefficacy of that method of treatment. Had the case been kept under observation, and the original measures repeated from time to time, as fresh growth occurred, there is every reason to believe that this man's life would have been saved.

The application of coagulating injections (perchloride of iron) was made by M. Broca to a circumscribed aneurism of the scalp, consisting of the con-

* *Bull. de Thér.* tome xlii. p. 354.

volutions of a cirroid artery. Many precautions were taken to prevent the extravasation of the fluid, and the case is reported as perfectly successful.* Another successful case is reported by M. Demarquay, in a large aneurism by anastomosis of the palm of the hand and middle finger, occurring in a child after the blow of a stone. Here the radial and ulnar arteries, however, were first tied.†

M. Gosselin (see p. 535) advocates the use of coagulating injections in all those cases of the disease to which he wishes to limit the designation of 'arterial cirroid tumours,' i.e. those of limited extent, and formed apparently by the dilatation of minute arteries—not capillaries. He gives three cases—one in the leg, one on the forehead, and the other at the root of the nose—in which this treatment was successfully adopted.

Before quitting the subject of cirroid aneurism, it may be well to notice that the disease is said to have occasionally undergone spontaneous cure. A patient was exhibited by Dr. Krackowizer to the New York Pathological Society in whom this had occurred, at any rate to a great extent; pulsation having disappeared, and the tumour having become solid and shrivelled in some of its parts; and the continuous rushing noise formerly perceptible to the patient being now inaudible while he was quiet. The patient was forty-five years of age, and the disease had lasted all his life, and had grown to a considerable size, but without pain or hæmorrhage. In the same communication, Dr. Krackowizer referred to two other cases as being recorded by Orfila and Chevalier.‡

DISSECTING ANEURISM.

The affection which bears the name of Dissecting Aneurism is so seldom recognised during life, and when it is the subject of treatment falls so much more commonly under the care of the physician, that a very few words must suffice for its description here. The anatomical lesion consists in a rupture of the internal coats of the artery, by which the blood is allowed to pass in an unnatural channel between the coats of the vessel, parallel to its course, until finally it passes again through the coats, so as to enter the cavity of the artery again, if its course has been forwards, or falls back into the pericardium if it has made its way backwards. Dr. Peacock§ has shown that a layer of the middle coat usually is left external to the blood, which is therefore extravasated into the thickness of this coat, and has also shown that the existence of this more resisting membrane confining the blood renders rupture into the pericardium or the

* *Bull. de la Soc. de Chir. de Paris*, 1866.

† *Gaz. des Hôp.* 1868, pp. 117, 126.

‡ *New Syd. Soc. Biennial Retrospect*, 1865–6, p. 303.

§ *Contributions to the Pathology of the Heart and Arteries*, 'On Dissecting Aneurism.' Edinb. 1849.

cellular tissue probable. When the coverings of the blood are strong, and the fluid finds a ready passage back into the artery, life may be prolonged for a considerable period. In fact, the symptoms referred to the disease have been observed to last for years. It is not impossible that in some such cases a dissecting aneurism may pass into a common 'false aneurism.'*

The position of the original rent seems always to be in the aorta, and generally in the arch, quite close to its origin, though it has been known to be situated in the abdominal aorta, even as low as its bifurcation. The position of the secondary rupture of the inner coats, by which the blood passes back into the cavity of the vessel, varies much. A case is mentioned in which the separation extended into the popliteal artery; and in another case, in which the primary rent was in the transverse arch, the secondary opening was in the subclavian.

Death occurs soon in all cases where the blood passes out of the artery, either into the pericardium or into the surrounding tissues; and in most of those in which the blood makes its way back into the artery. But in the few instances of the latter class in which life has been protracted for years, the unnatural channel running along by the side of the natural artery is lined by a smooth membrane resembling epithelium, and thus simulates a double vessel.

The symptoms of dissecting aneurism are best illustrated by a very interesting case reported by Dr. Swayne and Mr. Keyworth of York,† in which the diagnosis was accurately made during life, and confirmed by dissection.

In that case, a man aged fifty-one, who had suffered for some time under symptoms referred to diseased heart, with aortic regurgitation (to which diagnosis one of his medical attendants, Dr. Latham, had added disease of the aorta), was seized suddenly one evening, as he was returning from a day of some exertion and excitement, with a very severe tearing pain in the chest, instantly followed by a second agonising pain, which seemed to dart from mid-sternum down the left of the spinal column, and only to be arrested a few fingers'-breadth below and to the left of the umbilicus, at which point of arrest the patient thought he heard a distinct crack. He lost power in both lower extremities almost immediately, and the pulse became imperceptible in all the arteries of the lower limbs. A bellows murmur was heard below and

* Thus, in a case cited by Dr. Peacock (op. cit. p. 7), where the patient survived some years; 'the sac commenced at the origin of the aorta, and terminated in a cul-de-sac at the common iliac arteries.' So that nothing except its shape and extent would distinguish it from false aneurism.

† *Path. Soc. Trans.* vol. vii. p. 106.

to the left of the umbilicus. The 'tearing' pain recurred, and he then passed into a state of syncope, followed by great exhaustion and distress. Reaction set in next day, with much congestion, greatly relieved by bleeding. He survived about three months, dying of dropsy and hydrothorax. The pulse had recurred feebly in the right femoral artery before death. The diagnosis of dissecting aneurism, originating near the root of the aorta and passing down so far as to compress the true channel of the vessel near its bifurcation, was made at the time of the seizure and confirmed by dissection. A transverse rent was found in the arch of the aorta, just below its three large branches; a clot of blood was impacted near the bifurcation of the artery, obstructing the left common iliac completely and the right partially. The old canal of the aorta seems to have been disused, and the arteries to have communicated with the new channel.*

This case will serve to illustrate the usual run of the cases of dissecting aneurisms, though it is rare for the symptoms to be so well marked or so well observed; and therefore the disease is seldom recognised or even guessed at during life. The patient is usually advanced in life, very probably a female, and suffering from hypertrophy or other disease of the heart. The first symptom is a lancinating pain in the chest, corresponding to the seat of rupture followed by syncope; perhaps by pain at the part where the blood re-enters the artery, or where the tumour ceases. And this may be accompanied by the cessation of pulse from impaction of clot in the old channel of the artery, aided by the pressure of the blood in the unnatural channel. This stoppage of the pulse of course causes more or less complete loss of power. In other cases, where the rupture occurs near the heart and the blood falls back into the pericardium, death is sudden. I can add nothing as to the diagnosis of the disease which may not be gathered from the symptoms in the above case. The only case in which I can conceive such an affection becoming the subject of surgical diagnosis, is where loss of power, loss of pulse, and threatening gangrene follow on dissecting aneurism; and the diagnosis lies between this disease and embolism from the more ordinary causes of impacted clot.

* In this case, Dr. Swayne, after having his attention specially drawn to the fact by Dr. Peacock, distinctly asserts that the extravasation was *between* the external and middle coats.

GENERAL OBSERVATIONS ON THE LIGATURE OF ARTERIES.

It is in operations for the ligature of arteries that the proceedings of the operating theatre most nearly resemble those of the dissecting room; and it is in these operations, more than in any others, that minute anatomical knowledge is advantageous. Before undertaking to tie an artery, the surgeon ought to know its general course and its relations, and especially the prominent part or parts which are to guide him to the position of the vessel (to serve as rallying points, as the French operators say); he ought to have familiarised himself by frequent dissection* with the thickness of the parts covering it, and their appearance, as far as that can be judged of on the dead body; and, finally, he ought to know the usual position of its principal branches, and the anastomoses by which the circulation may be expected to be restored. It is advisable also to be aware of the leading peculiarities in course, relations, bifurcation, &c., which the operator may perhaps meet with, and for which he ought to be prepared.

Having all these anatomical details clearly present to his mind, and being familiar with the various methods by which the vessel can be reached, the surgeon will be prepared to adopt that method which seems to him best suited to the case which he happens to have before him. It is better, if possible, to avoid the part of an artery where large branches are known to come off, since in such cases the clot that should form in the vessel during the process of its severance will be absent between the ligature and the opening of that branch; and although it is true, as has been shown above,† that the clot is not necessary as a preservative against secondary hæmorrhage, inasmuch as the wound in the artery unites by lymph, which seals it, and acts as a barrier to the blood; yet that barrier is certainly

* So experienced an operator as Sir P. Crampton relates, that before tying the common iliac artery he practised the operation seven times on the dead subject, and says that each time he did so he learned something towards the satisfactory performance of the operation.

† See Guthrie's *Comment.* ed. 1855, p. 80; Porter, *On Aneurism*, p. 187; Aston Key, in *Guy's Hospital Reports*, vol. i. pp. 65, 63.

strengthened by the clot in the artery, as is shown by the fact that secondary hæmorrhage is less common in situations where a long internal coagulum is formed.

In dissecting down upon an artery, it is important to have a clear view of each successive structure as it is exposed; and therefore bleeding from any small veins or arteries that may be divided in the superficial incision should be at once restrained by ligature or pressure. No attempt should be made to hurry over the proceedings; but as each layer of tissue is divided, the one below should be carefully examined with the eye and finger. Most large arteries run in a sheath of fascia, which also contains their accompanying vein. When the level of this sheath is reached, great care must be taken in applying the knife. The cellular membrane or muscles over the sheath having been properly divided or drawn aside, that structure itself should be cleaned by scratching with the finger, assisted by the blunt point of a director or silver knife. When the sheath has been fairly exposed, and the beating of the artery can be plainly felt through it, a small part of the membrane should be raised by the forceps and divided with the knife held horizontally, as is done in opening the sac of a strangulated hernia. The small hole over the artery must be extended with the point of the director or aneurism needle,* till a little channel has been made round the vessel, through which the thread can be carried easily. Great care is necessary to use the instruments with all gentleness at this stage of the proceeding, on account of the proximity of the vein. The needle is to be passed under the artery, in a direction away from the vein; *i.e.* the point of the needle is first passed between the artery and vein, and brought out on the side of the artery away from the vein.† When the needle has been passed under the artery, the latter should be compressed between the point of the finger and the curve of the needle, in order to see that the beating in the tumour is completely stopped, or the bleeding completely commanded; and to judge also by the

* Mr. Syme, however, whose experience in tying arteries is perhaps more extensive and more favourable than that of any other living operator, prefers cleaning the artery with the edge of the knife, using it till the whitish coat of the artery is clearly seen. If this plan is adopted, great care must be taken in scratching the vessel; and perhaps it will be well to blunt the edge of the knife a little.

† Further directions as to tying arteries for a wound will be found in vol. i. pp. 751 et seq.

feeling that no other structure has been taken up with the vessel. This is the more necessary in cases where the artery, as in the case of the subclavian, lies very deeply, perhaps out of sight, and touching a large nerve or other important structure.

Some difference of opinion exists about the administration of chloroform in operations on arteries. M. Robert* advocates the performance of these operations without anæsthetics, but the contrary practice is now universal, and I think rightly so, in this country. Opinions differ also as to the direction in which the incisions may be most advantageously made. Most operators make their incisions in the course which the vessels are known to pursue; others prefer an incision which crosses obliquely the course of the vessel. The former plan enables the operator more clearly to anticipate and recognise the structures successively exposed; the latter renders him more certain not to miss the vessel altogether, and also enables him more conveniently to investigate the parts around, should any anomaly, such as a high bifurcation of the brachial or femoral artery, render it necessary to search about, without any definite anatomical guide, for a vessel not usually present.

Large arteries ought not to be tied unless a reasonable probability exists of the recovery of the patient from an operation which must always be grave, and which is far more fatal than most surgeons appear inclined to admit; but if the disease or injury admits of no other cure, nothing need be held to be a formal contra-indication to the operation; not disease of the viscera, not disease of the heart, not even disease of the artery itself, although it must be allowed that the latter complication renders the case almost hopeless.† But, on the other hand, the most mature consideration is requisite to assure the surgeon that the case is really beyond the reach of other and milder measures. So much has lately been done to diminish the percentage of cases of aneurism which require ligature, that it may now be said that the presumption in a case of surgical

* *Conf. de Clinique chir.* Paris, 1860, p. 48.

† If the artery on which the operation is performed be found, when exposed, to be extensively diseased, four courses are open. In aneurisms of the extremities, the safest course would be to amputate; in a few cases the surgeon might resort to acupressure; usually, the operation would be completed; while sometimes the case would be abandoned to nature. Under the head of ligature of the innominate, a remarkable instance of the good result of the latter course will be mentioned. The surgeon must rely upon his own judgment.

aneurism is rather that it is curable without operation than that an artery will require ligature. It will be my object in the following remarks upon each particular form of surgical aneurism, to point out in what cases milder measures may be expected to succeed; and when these fail, by what operations the affected arteries or the trunk above them can be reached; and in treating of each form, I shall observe the same order as is followed in the essay on AMPUTATION, taking the upper limb first, with the head and neck, and proceeding from the extremity towards the trunk.*

ANEURISMS IN THE FORE-ARM AND HAND.

Aneurisms diminish in frequency as the vessels diminish in size; hence the disease is very rare in the fore-arm and hand; indeed, is hardly ever seen except as the result of accident. I was enabled, however, through the kindness of Mr. De Morgan, to see a case of aneurism of the upper part of the ulnar artery among his patients at the Middlesex Hospital. In this instance, as I suppose would usually be the case, the whole of the arterial system was diseased, and a loud murmur accompanied the action of the heart.†

There is generally little difficulty in diagnosing an aneurism in the hand or fore-arm, nor in determining whether it be simply arterial or arterio-venous. The treatment of spontaneous aneurism of these arteries would be exceedingly simple if the disease could be found in a subject otherwise healthy. Digital pressure on the artery leading to the aneurism, maintained by the patient himself as long as he was able for several days, much reduced the size and pulsation of the tumour in the case above mentioned. If this or other forms of pressure failed, recourse would be had to the Hunterian operation, and even in the last resort the old operation would present no great diffi-

* In speaking of the ligature of arteries, it has been found impossible to separate the cases in which such operations are required for aneurism and for injury; but as the former class of cases is by far the larger, it was judged best to include the description of all the operations in the present essay.

† Typical examples of traumatic aneurisms in the fore-arm will be found in Ormerod's *Clinical Collections*, pp. 150-1. A case of spontaneous aneurism of the radial artery was under Mr. De Morgan's care at the Middlesex Hospital, and recovered spontaneously, and an aneurism of the ulnar, the result of embolism, under Mr. Pollock's care, is figured at p. 422. See also Erichsen, op. cit. vol. ii. p. 98; and the figure on p. 414 of this essay.

culty. I have performed it with great ease and success in a small traumatic aneurism of the superficial palmar arch. A case is referred to on p. 456 (note), where a small aneurism in the palm was successfully extirpated by chloride of zinc.

The arteries of the fore-arm far more often require ligature on account of a wound. It is hardly necessary to give minute directions for the performance of such operations as tying the ulnar or radial near the wrist. Common sense would suggest to keep the tendons intact; and this being done, and care taken to avoid mistaking a nerve or piece of fascia for the artery, all the cautions necessary for the operation are exhausted. It is a matter of indifference whether the *venæ comites* are included in the ligature or not.

If the skin is unbroken, as when the radial or ulnar, or both, are tied for a wound in the palm of the hand, it is merely necessary to make an incision, from an inch to two inches in length, between the tendons which accompany the vessel, divide the deep fascia, which is often strengthened by a distinct thin layer over the ulnar artery; and if the tendon of the flexor carpi ulnaris overlaps the vessel (as is usually the case), draw it inwards, and then the vessel will be exposed by a little dissection enclosed in its sheath—the radial accompanied merely by a small filament of nerve lying above the fascia, which probably will not be seen, the ulnar having its nerve on its inner side.

The radial can be exposed, if necessary, higher up, by a similar operation; but now the muscular belly of the supinator longus requires to be drawn outwards, and the position at which the radial nerve lies against the artery (on its outer side in the middle third of the fore-arm) must be remembered. The different directions of the fibres of the supinator longus and pronator teres must be borne in mind. Their vertical direction will always distinguish those of the former muscle.

Ligature of the ulnar artery near its origin is a much more difficult operation. It is only required, as far as I know, in cases of wound. The very commencement of the artery may be exposed after the division of the bicipital aponeurosis, without cutting through any muscular fibres; but the depth of the parts is very considerable, and where there is much effusion of blood, it is by no means easy to recognise the wounded vessel, which may be the humeral itself, or either of its branches. In the only case where I ever saw this operation attempted, it was given up and

the arm amputated. On examination it turned out that all three arteries were injured, the bifurcation of the main trunk having been cut across. To tie the artery a little lower down, Mr. Guthrie* recommends that an incision should be made through the aponeurosis of the biceps, the pronator teres exposed and drawn towards the ulna, and the dissection continued till the median nerve is brought into view, crossing the artery from without inwards. Then, if it is necessary in order to reach the vessel, part or the whole of the pronator teres is to be divided. In other cases it may be more convenient to divide the muscles from below, an incision being made from the point at which the muscular and tendinous portions of the flexor carpi ulnaris are felt to join, upwards for four inches, and the sheath exposed as the vessels emerge from beneath the flexor sublimis digitorum. If the wound be higher up, the division of the latter muscle, and even of those adjoining it, if it be necessary, may be pursued from this point. More or less loss of power will probably follow the division of the muscles, especially if extensive; but this is likely to be transient, and if not, it is a less evil than the loss of the hand. The nerve will probably be the first of the structures around the artery which comes into view.

At the bend of the elbow aneurismal swellings are almost always traumatic, and generally are of the arterio-venous class. If the disease be a simple arterial aneurism, whether traumatic or spontaneous, pressure upon the brachial artery is the first resource of the surgeon. Acute flexion of the limb will very probably succeed, either by itself or as an accessory to the indirect compression. If these means should fail, the natural course, irrespective of any special complication, will be to tie the brachial artery. The treatment of arterio-venous aneurism has been discussed above (pp. 530-533); we need not, therefore, detain the reader on the diagnosis or treatment of aneurism at the bend of the elbow; nor does that of aneurism in the arm call for any further remark. We have, then, only to describe the operation on the brachial artery, which may be required for these affections.

Ligature of the brachial artery for aneurism, or for wound of the lower part of the limb in which the wounded artery cannot be secured, is thus performed. An incision is made, about

* *Commentaries*, p. 294.

three inches in length, along the inner margin of the biceps muscle in the middle of the arm; or if that muscle be obscured by œdema, fat, or imperfect muscularity, then in a line drawn from midway between the two flaps of the axilla to the middle of the bend of the elbow. In making this incision, perhaps the basilic vein will be seen, and should be avoided. The fascia having been divided upon a director, the operator comes down immediately to the packet of vessels and nerves. The internal cutaneous and ulnar nerve lie to the inner side of the artery, and may or may not come into view; or perhaps the external cutaneous will be seen on the other side of the vessels. The difficulty of the operation (which is sometimes considerable) consists in recognising and isolating the artery. What renders this more troublesome is, that the artery, besides being closely surrounded with other structures, does not always maintain the same relation to them. The median nerve is more commonly above the artery, and is the first cord seen below the fascia; but occasionally it will be found under the artery. Again, the brachial artery may not be the only vessel which requires ligature, since another considerable vessel may exist in the neighbourhood (probably a radial artery given off high up, or a *vas aberrans*), which will have to be sought;* it is, however, usually found close to the one first exposed. The veins often encircle the artery with an intricate plexus of anastomosing branches; hence the operation is frequently far less easy than the superficial position of the vessel would seem at first sight to promise. It is true that a little patience and anatomical knowledge will dispose of these difficulties; but they should not be forgotten in deciding the question of treating an arterio-venous aneurism at the bend of the elbow, since, besides the other objections to the Hunterian ligature, it may be said that, as an operation, it will very likely be found no easier, and perhaps much more difficult, than the old operation.

Ligature of the brachial artery is usually very successful, as far as the operation itself goes. It is true that in Porta's statistical table of six hundred cases of ligature of all arteries, ten out of sixty-eight cases of ligature of the brachial artery are said to have died; but in the absence of details we cannot tell whether they died from the effects of the operation. Gangrene is, however, believed to be sometimes a consequence of the

* See the figure on p. 525.

application of a ligature to the upper part of the brachial artery, the anastomosis between its branches and those of the axillary being rather scanty (vol i. p. 741).

AXILLARY ANEURISM.

Axillary aneurism, like popliteal, depends in a large proportion of cases upon injury, more or less severe, to the artery, in the violent movements of the joint near which it lies.* This injury may, as it seems, vary from complete rupture of the vessel to some slight contusion or strain, only appreciable by its results. In the former case the aneurism is of the consecutive, in the latter of the false, variety. So far there is little essential difference between axillary and popliteal aneurism. But the different anatomy of the parts occasions a great difference in the curability of these affections. The cellular space of the axilla is so loose and so large, that the tumour may attain a very unmanageable development before any treatment is called in. So that the great advantage which is always obtained in an aneurism by the condensation of the parts around the sac, and the commencement of spontaneous cure in the deposition of laminated fibrine, is less likely to occur in axillary than in other aneurisms; while the growth of the tumour, even if opposed by coagulum in one part, can easily go on in another. Further, in the treatment of axillary aneurism the Hunterian operation is less likely to be successful, since, instead of an artery pursuing a long and comparatively superficial course, without any considerable branches, as the superficial femoral does, the vessel upon which the axillary aneurism is formed is short, deep, and so crowded with large branches, that a ligature can only be applied in close promixity to one or other of them.

It is often said that axillary aneurisms are more difficult to treat than others, because they are so often traumatic. But this seems to me a confusion of terms. A *traumatic aneurism* is more easy to treat than a spontaneous aneurism. What is meant is, that there is so often no aneurism at all, but only a lacerated artery; and a lacerated artery is not much more amenable to indirect methods of treatment than a wounded one.

* On the subject of subcutaneous laceration of the axillary artery, I would especially refer the reader to Mr. Callender's paper 'Respecting Rupture of the Axillary Artery in reducing Dislocations at the Shoulder-joint,' in vol. ii. of the *St. Bartholomew's Hospital Reports*.

The presence or absence of a sac determines this point, and this fact is shown by the presence or absence of *pulsation*. I venture to think, with all possible deference to the great authority of Mr. Syme, that in his paper on the subject of axillary aneurism,* which gave a new impetus to the discussion of the very interesting question of the treatment of that affection, this point has hardly been made sufficiently plain to the reader, although it may have been present to the mind of the author. Mr. Syme begins his essay with the rather startling avowal that the doctrine, which he had been teaching for more than thirty years, of the superiority of the Hunterian operation to the old mode of treating aneurism, is questionable. But the instance upon which he supports this assertion is one in which, accurately speaking, there was no aneurism at all. The history of an accident, the presence of a large and increasing collection of blood, an arterial bruit, and no pulsation, afford as clear evidence of laceration of the artery, unaccompanied by the formation of an aneurismal sac, as can be obtained; and in such cases, whether they be in the axillary space or the popliteal, the Hunterian operation may be expected frequently to fail; and the only sure resource is to tie both ends of the bleeding vessel.† Still the situation of the injury will very much modify the treatment which would be recommended. In the popliteal space the old operation is very difficult and very fatal, while the Hunterian operation is easy. On this account, when the popliteal artery is ruptured, the ligature of the femoral artery has been practised, though unsuccessfully.‡ Amputation is here usually the proper course. But in the axilla, the old operation has been found, in skilful hands, not more difficult than the ligature of the subclavian; it is possible that it may prove less fatal; and it is certain, if not fatal, to cure the disease, which

* *Med.-Chir. Trans.* vol. xliii.

† 'We must not be led away,' says Mr. Erichsen, 'by the term *aneurism*, which has been applied to these cases, and not treat such a condition, resulting from wound or subcutaneous laceration, by the means that we employ with success in the management of that disease. In the diffused traumatic aneurism—[which is Mr. Erichsen's term for a ruptured artery]—there is no sac, properly speaking; and hence those changes to which a sac is necessary cannot take place. I doubt whether there is a case on record, in which the Hunterian operation for aneurism, applied to the condition now under consideration, has not terminated in danger or death to the patient, and in disappointment to the surgeon.'—*Science and Art of Surgery*, i. 200.

‡ See below, Ligature of the Popliteal Artery.

ligature of the subclavian may fail to do. Hence, in a case of effusion of blood in the axilla from accident, where no indications of a sac exist, most surgeons would agree with Mr. Syme that the ligature of both ends of the injured vessel is a far more rational and more promising proceeding than the ligature of the subclavian, if either operation be requisite. But both are formidable operations, difficult to carry out satisfactorily, and even when performed in the most dexterous manner very dangerous to life. In spontaneous aneurism, or in traumatic aneurism properly so called, *i.e.* in tumours the outlines of which are well defined, the pulsation plainly perceptible, and which can be emptied by pressure if the circulation be commanded, what course should be pursued? Mr. Syme appears to be in favour here also of emptying the sac and tying the artery above and below it, and has performed the operation once successfully. Other surgeons would prefer to tie the subclavian, in spite of the great mortality with which that operation has been attended.* Perhaps the decision will be best made according to the circumstances of the individual case. If the tumour extend far up, so that the clavicle is much raised, and the neck short and fat, the operation on the subclavian is so dangerous and so difficult that it would be better to operate on the aneurism. In contrary circumstances (*i.e.* where the subclavian triangle is easily accessible and the aneurism buried deep in the axilla), the subclavian may be tied with good prospect of cure. The objection to the old operation, which rests on the probably diseased condition of the artery near the tumour, has less force in this situation than in the popliteal space; since in any case the ligature must be placed near the aneurism.†

But would not all these affections, *viz.* ruptured artery, traumatic aneurism, and spontaneous aneurism, be found amenable to milder treatment if it were more perseveringly tried? It will strike the reader of most of the cases of axillary aneurism, in

* Especially in the practice of London surgeons during the last few years. See below, on Ligature of the Subclavian Artery.

† On this head I would refer the reader to a very interesting case of axillary aneurism, too long to quote, by Dr. Morton, in the *Am. Journ. Med. Sc.* July, 1867, p. 70, in which the left subclavian artery was tied in its second part, between the scaleni; the tumour suppurated, hæmorrhage occurred on the forty-third day, and the limb became gangrenous; a vessel believed to be the subscapular was tied; the limb was removed at the line of demarcation; hæmorrhage recurred; and the stump was removed from the shoulder-joint successfully.

which the details are fully given, how well adapted they seem to have been for the treatment by digital pressure, had that method been known.* At any rate, if moderate pressure on the artery where it crosses the first rib can be made (as it often can), by means of the finger or a pad, so as to control the circulation, the surgeon is not doing his duty to his patient if he expose him to the risk of a great operation without a careful and patient trial of this safe and often most successful method.† If direct pressure by a pad in the axilla, or by bandaging the arm across the chest, appears to assist in controlling the pulsation and bruit, it may be at the same time employed. Instrumental compression is less easy on account of the shape of the parts, and is less likely to be well borne from proximity of the large nerves to the subclavian artery; but it might possibly be advisable to try it in the absence of a sufficient staff of assistants to make pressure with the fingers. If these means fail, one or the other of the operations above discussed must be performed.

Mr. Syme thus describes the operation which he performed on the case of ruptured axillary artery on which he first practised the *old operation*: 'Chloroform having been administered, I made an incision along the outer edge of the sterno-mastoid muscle, through the platysma myoides and fascia of the neck, so as to allow a finger to be pushed down to the situation where the subclavian artery issues from under the scalenus anticus, and lies upon the first rib. I then opened the tumour, when a tremendous gush of blood showed that the artery was not effectually compressed; but while I plugged the aperture with my hand, Mr. Lister, who assisted me, by a slight movement of his finger, which had been thrust deeply under the upper edge of the tumour and through the clots contained in it, at length succeeded in getting command of the vessel. I then laid the cavity freely open, and with both hands scooped out nearly seven pounds of coagulated blood, as was ascertained by measurement. The axillary artery appeared to have been torn across; and as the lower orifice still bled freely, I tied it in the first instance. I next cut through the lesser pectoral

* See a case described by Pelletan, *Clin. chir.* vol. ii. p. 50. 'By raising the shoulder slightly, the subclavian artery could be felt isolated; and by making even slight pressure with the finger, its pulsation and that of the entire tumour could be arrested.' So also in Mr. Crossing's case, in *Med.-Chir. Trans.* vol. xvi. p. 344, pressure on the artery as it crossed the rib was easily made; and the same may be said of Mayo's case, *ibid.* p. 360; and of Mr. Poland's in vol. lii. of the same *Transactions*. I merely instance these cases among many others to which the same remark applies.

† Mr. Poland has related a case in which digital pressure was used with success in the treatment of a small aneurism of the subclavian artery (*Med.-Chir. Trans.* vol. lii.). Here, however, the artery rose much higher in the neck than usual, and was supported on a process of bone, possibly a cervical rib. The presence of such a rib would much facilitate the application of digital pressure to the subclavian artery.

muscle, close up to the clavicle; and holding the upper end of the vessel between my finger and thumb, passed an aneurism-needle, so as to apply a ligature about half-an-inch above the orifice.*

Mr. Syme adds the important remark, that the extreme elevation of the clavicle occasioned by the great effusion in the axilla, which rendered the artery so inaccessible from above, facilitated this proceeding from below. It was no doubt the same circumstance, of the great depth at which the third part of the subclavian was situated, which rendered it necessary to make an incision over it through the deep cervical fascia before effectual pressure could be made on it; a precaution which ought to be taken in all similar cases.

Ligature of the axillary artery after the Hunterian method.—The axillary artery is sometimes, though rarely, the subject of operation for aneurism in the arm, the result usually of injury. This operation has been much decried, on the supposition that the necessary proximity of large branches to the ligature would surely lead to secondary hæmorrhage. We have, however, as above noted, the high authority of Mr. Guthrie, and others, for saying that this apprehension is exaggerated. The depth at which the artery lies, and the necessity for cutting through a mass of muscle to expose it, form another, but not a very powerful, objection to the operation, which seems, notwithstanding this, to have been often effected without much difficulty. Chamberlaine† tied the axillary artery just below the clavicle, by a horizontal incision parallel to the lower edge of the bone, commencing about three fingers' breadth from the sternal end of the bone, and terminating about an inch from the acromion. 'A second incision of about three inches in length was made obliquely through the integuments over the deltoid and pectoral muscles, meeting the first nearly in the centre. Then the clavicular origin of the pectoralis major was separated from the bone, and the artery brought into view by removing the fat and cellular membrane.' The only difficulty experienced was in passing the needle, in consequence of the depth of the cavity and the struggles of the patient. It was accomplished by passing an eyed probe under the vessel, the blunt end first, as I understand the account. The patient made a good recovery. Roux‡ appears to have succeeded in tying the artery above the coracoid process, by an incision parallel to the course of the vessel, between the deltoid and pectoralis major, without dividing any muscular fibres; but his description is not very

* *Med.-Chir. Trans.* vol. xliii. p. 141. † *Med.-Chir. Trans.* vol. vi. p. 128.

‡ *Quarante Années, &c.* vol. ii. p. 133.

full. Most surgeons would think that the greater room and better view of the parts obtained by the division of the muscular fibres would be a great advantage, and would therefore prefer the former method.

In both these operations the artery is sought from above ; an operation which Mr. Guthrie vehemently condemns.* The operation which he proposes to substitute is one by which the artery is sought from below, which would of course be the preferable operation if the lower part of the artery (that below the pectoralis minor) is to be operated on, and by which Mr. Guthrie says that any part of the artery can be exposed, and the whole vessel traced up to the first rib, if required. An incision three inches long is to be made over the course of the artery upwards from the lower edge of the pectoralis major, and perpendicular to the course of its fibres. These having been divided a full view of the axilla and its contents is obtained. If the operation is done for a wound, the bleeding mouth of the artery will be seen by relaxing (if necessary) the pressure which, in such a case, will have been put on the subclavian. Mr. Guthrie says, that 'the finger introduced into the upper part of the wound would enable the operator to divide the pectoralis minor muscle if necessary, or to draw it upwards ; when the artery, vein or veins, and the plexus of nerves, might be traced up to the first rib without difficulty.' Nevertheless, in any operation on this artery, the large vein which lies in front, and to the thoracic side of the vessel (sometimes, as Mr. Guthrie hints, double), the numerous large nerves which surround it, and the great quantity of branches which are given off from the artery, and which again give off large and numerous vessels towards the inner and front parts, where the operation must be conducted, will occasionally prove embarrassing to the most dexterous operator, though in other cases, as in those above referred to, the surgeon may have the good fortune to escape them.

Of the success of this operation, no sufficient data exist to enable us to judge ; it appears, however, both from published cases and *à priori* reasoning, that little danger of gangrene exists if the artery be tied above the origin of the subscapular, since that artery anastomoses so freely with branches of a higher origin (posterior and supra-scapular), that the blood is

* *Wounds and Injuries of Arteries*, p. 54.

most readily conveyed around the ligature. Secondary hæmorrhage is more to be apprehended, and we may conjecture that diffuse suppuration in the loose cellular tissue of the axilla would often ensue.

I will not detain the reader with any remarks in this place upon the consequences of wounds of the trunk of the axillary artery, as distinguished from those which follow the division of one of its large branches near the trunk. The persistence of pulse at the wrist or in the brachial artery is the main feature in the diagnosis; the extent and the advance of extravasation of blood the circumstance which decides the necessity of cutting down on the wounded vessel.*

Ligature of the subclavian artery in the third part of its course may be thus effected. The patient is to be laid down on the sound side; the arm should be depressed as far as the tumour will allow, in order to draw the clavicle as much as possible out of the way of the artery; the skin of the neck should be pulled down into the chest by the fingers of the operator's left hand, while he makes an incision down to the bone along the prominent part of the clavicle, from the edge of the sterno-mastoid to the trapezius. The skin is now allowed to retract, when the incision will lie above and parallel to the clavicle. In this way the external jugular vein, which here dips below the clavicle, will be avoided, and may be drawn with a blunt hook inwards or outwards (the former will generally be found more convenient) during the rest of the proceedings. If the muscles approach near to each other, the sterno-mastoid ought to be partly cut away from the clavicle.

If the patient be stout, or the clavicle much pushed upwards, so that the artery lies at a great depth, it is advisable to connect the transverse incision with one running upwards from its inner end, and dissect the flap outwards.† The cervical fascia must now be cautiously divided on a director to the extent of the wound, commencing from the outer edge of the sterno-mastoid, when the knife may be laid aside, and the parts separated by means of the finger, assisted by the point of a director or other blunt instrument. The finger of the operator is now passed

* See John Bell's *Surgery*, Charles Bell's ed. 1826, vol. i. p. 416.

† Or a flap may be formed by an angular incision projecting beyond the sterno-mastoid muscle, and this flap dissected inwards. (Skey, *Operative Surgery*, 1st ed. p. 220.)

into the 'subclavian triangle,' a small space bounded by the omohyoid muscle above, the clavicle below, and the sternomastoid at the inner side. Lying somewhat parallel to, but deeper than, the sternomastoid is the scalenus anticus muscle, which must always be carefully sought and traced down with the fore-finger into the first rib. When the point of the finger is placed upon the ridge on which this muscle is inserted into the rib (and which terminates on the inner border of the bone, in a very perceptible tubercle), the artery will be felt immediately under the finger. The other structures contained in this triangle are two branches of the thyroid axis, the transverse cervical and supra-scapular, the veins accompanying them which empty themselves into the external jugular, the brachial plexus of nerves, with some small branches, and finally an absorbent gland. If the transverse cervical artery should be divided, it will be tied without difficulty. The supra-scapular is usually below the clavicle, and is not seen. It did, however, come into view in Dr. Warren's case,* and it was not without difficulty that he was enabled to avoid it; which, as Dr. Warren remarks, it is important to do, both on account of the difficulty that might be experienced in securing it, and because it is an important agent in the collateral circulation. Should either of the veins, or even the external jugular, be much in the way, it may be tied with two ligatures and divided. The gland may be removed without scruple if necessary.† Much care is required to separate the artery from the lowest cord of the plexus, which lies so close to it that it often derives pulsation from the artery, and appears to be a part of it. This mistake is more liable to be committed when the artery is so deep as not to be easily brought into view. It is on this account that it is of so much consequence in these cases to keep the finger carefully on the anterior scalenus muscle, since the artery is more easily recognised by its position with respect to that tendon than by anything else.

This operation varies much in difficulty. On the dead subject, or in the living when the person is thin and the parts natural, nothing is more easy; on the contrary, when the clavicle is driven upwards, is greatly curved, as in persons accustomed to manual labour, and the patient stout and muscular, it is one of the most difficult of all the operations on

* *Infra cit.*

† See a case by Mr. Crossing, in *Med.-Chir. Trans.* vol. xvi. p. 340.

arteries. In these latter circumstances, the artery lies at the bottom of a deep cavity liable to be filled with blood oozing from the many small vessels which will probably be divided in such a case, and the parts cannot be distinguished. It is not wonderful, therefore, that such operations occupy much time, and sometimes terminate in disaster. Two successive cases of Dupuytren's are on record;* in one of which everything went on favourably; while in the other the operation occupied an hour and forty-eight minutes, and on the death of the patient, four days afterwards, it was found that the ligature had been thrust through the vessel, and included one of the large nerves of the brachial plexus, along with half the artery. Another accident to which the operation is liable in complicated cases, is an injury of the pleura, or disturbance of the subserous cellular tissue which connects that membrane to the first and second parts of the subclavian artery. Thus, in a case of much difficulty operated on by Dr. Warren in America,† the air rushing into the chest with a whistling sound gave evidence of the infliction of a wound on the pleura. The patient nevertheless recovered. Mr. Aston Key‡ considers that pleurisy and the inflammation of the subserous cellular tissue leading to abscess in the anterior mediastinum will be found to be the most common causes of death in this operation—an opinion which the statistics quoted below go far to support; and points out the necessity that there is, on this account, for not meddling if possible with any part of the vessel except that which lies immediately on the rib, by which means such an injury to the serous membrane or subserous tissue will be avoided.

That ligature of the subclavian artery should be a very fatal operation, when performed for axillary aneurism, will surprise no one who considers the conditions under which it is performed. In the first place, the procedure resembles Anel's operation almost as much as Hunter's.§ Hence suppuration of the sac from loose formation of clot, and secondary hæmorrhage from disease of the artery, may be anticipated. Again, the ligature

* See Quain's *Anatomy*, ed. 1848, vol. i. p. 504.

† *Med.-Chir. Trans.* vol. xxix. p. 32.

‡ *Med.-Chir. Trans.* vol. xiii. p. 8.

§ It differs indeed in principle from Anel's—so far as Anel's method can be said to have any principle: for as the aneurism may be seated below the acromio-thoracic artery, an anastomotic arch may continue the circulation through the sac after operation; but this cannot be calculated on.

must be placed in the immediate vicinity of large branches. Then, again, the deficient formation of laminated clot is further favoured by the absence or loose structure of the aneurismal sac, and by the want of resistance in the parts which surround it (see p. 552). For these reasons the sound cure of the disease is less probable, and suppuration in the sac far more common in axillary than in other aneurisms; and if to these sources of danger, those above noticed, which result from the anatomy of the parts, be added, we shall have, I think, a satisfactory explanation of the high mortality of the operation.

In Norris's table * of the statistics of this operation, sixty-nine cases have been collected in which the operation was performed for various causes. The result was most disastrous: thirty-six recoveries against thirty-three deaths; a mortality little less than what is supposed to prevail after amputation at the hip-joint. The few cases recently operated on in London, and reported in the *Medical Times and Gazette*,† have turned out still more unfavourably; out of six cases two only have recovered.‡ Porta's table of the published cases gives a more favourable account, since out of seventy-four cases twenty-seven only are reported to have died; but as Norris's and Porta's tables were both published in the same year, and as the thirty-three deaths in the former table did certainly occur (for the references to all the cases are given), it is clear that Porta must have missed some of the fatal cases. On the other hand, it is quite possible that Porta may have had access to some successful cases which were unknown to Norris; but the Italian tables not being accompanied by references, as the American are, it is impossible to say how many of Porta's seventy-four cases correspond with Norris's sixty-nine. The most favourable view of the case would be that which would assume that Porta had merely missed six out of the thirty-three fatal cases, and had tabulated all the rest. Now, adding these to his list would give thirty-three fatal cases out of eighty, a mortality of 41·25 per cent. It may safely be said, then, that the average mortality of ligature of the subclavian artery for all causes, and in all cases of hospital and private practice, town and country, taken indiscriminately, is considerably above 40 per cent.

As to the causes of this mortality, we get no information from Porta; out of the thirty-three deaths in Norris's table, five were unaccounted for; of the remaining twenty-eight, nine were caused by hæmorrhage, six by gangrene, five by sloughing or suppuration of the aneurism, five by intra-thoracic inflammation, one by exhaustion, one by effusion on the brain, and one by 'inflammation.'

These facts, as well as the theory of the matter, certainly tend to exhibit ligature of the subclavian artery as one of the least promising of all the surgical operations, and must dispose surgeons to try the method recommended to them by Mr. Syme in any case in which that procedure does not appear too dangerous.

* *Amer. Journ. Med. Sc.* 1845, vol. x. p. 13. † Vol. ii. 1856; vol. i. 1860.

‡ An interesting case in which both subclavian arteries were successfully tied at an interval of three years, was published by Mr. Furner in *Med.-Chir. Trans.* vol. li.

ANEURISM AT THE ROOT OF THE NECK.

This is one of the most formidable diseases which can occupy the attention of the surgeon; both the diagnosis and treatment are surrounded with difficulties that are usually found insuperable. The main cause of this is the proximity of the heart. It is exceedingly difficult to distinguish whether the bruit is limited to the tumour, or is propagated into it from the cardiac valves; whether the pulsation is limited to the neck, or extends also into the thorax; and whether one only of the large vessels is implicated, or whether others of the great arteries in the neighbourhood, or the whole trunk leading from the heart, may not be diseased and dilated. Then in the treatment, the proximity of so great a stream of blood has hitherto prevented the successful application of a ligature upon the innominate or the first part of the subclavian, for the cure of aneurism situated above the axilla.* The atheromatous deposit, which generally, when it exists at all in these large arteries, involves their whole calibre to a very great extent, has sometimes even prevented the surgeon from tying the artery after he has exposed it; and the probability of the existence of this state of the vessel renders it always a hazardous matter to attempt an operation.

First, as to diagnosis. The aneurismal nature of the swelling does not usually admit of any doubt; for though here, as elsewhere, malignant tumours springing from the bones may derive pulsation from their own vessels, or tumours of any kind from proximity to the arteries, such sources of ambiguity are less common than in other parts of the body. Reference may therefore be made on the head of diagnosis between aneurismal and other tumours, to what has been said in the section on Diagnosis, and to what follows upon Abdominal Aneurism. But it is often a matter of great importance and of great difficulty to discover whether the aneurism involves the subclavian artery, or the root of the carotid, or the innominate, or more than one of these vessels, or the aorta by itself, or in conjunction with one of its branches. Mr. Wardrop† lays it down as a rule by which aneurisms of these several arteries may be diagnosed from each other, that when the disease affects the root of the carotid, it will present itself first in the small triangular space between the heads of the sterno-mastoid muscle; whereas when the innominate is the seat of disease, it will generally be

* Except in one case, which will be referred to in the sequel, where the aneur-

found on the tracheal, and when the subclavian is affected, on the cervical, side of that muscle. These observations can, however, only apply to cases seen in the earliest period of the disease; and their deceptiveness even in such cases is shown by the fact, that out of the few cases cited by Mr. Wardrop, one* proved to be of the innominate artery, which ought, according to his rule, to have been of the subclavian. But though the place of the first external appearance of the aneurism is not decisive as to the part of the artery from which it springs, it is a symptom of considerable importance, and should always be carefully noted when it can be clearly ascertained. Another important symptom is the character of the pulsation in the branches of the carotid and subclavian. If the pulse in the brachial or radial, or that in the upper part of the carotid or the temporal, be materially less on the affected than on the sound side, we have some reason for believing the parent trunk (subclavian in one case, carotid in the other) to be affected; and in the opposite circumstances to be unaffected. But neither conclusion is free from some uncertainty. The growth of aneurisms in the cellular tissue of the mediastinum and root of the neck is so free, that instances have been observed of aneurisms of the arch of the aorta causing compression of the subclavian or carotid, without any disease of those vessels; † while on the other hand, if the aneurism approaches the tubular shape, the pulse may be unaffected in the branches, though the trunk is extensively diseased. Again, the influence of the anomalous distributions which so often affect the branches of the aorta is not to be forgotten. ‡ Possibly some assistance to the diagnosis may be obtained by a careful consideration of the other organs compressed by the tumour. Thus pressure on the great veins will lead to lividity, or even a permanently cyanotic condition of the extremity §

* Case of Gordon, p. 104.

† See cases by Allan Burns and A. Cooper, in Burns, *On the Surgical Anatomy of the Head and Neck*, pp. 60 et seq. 1844.

‡ I have seen a case in which, from other symptoms, there was no difficulty in diagnosing an aneurism of the arch of the aorta; but one circumstance was difficult to account for, viz. that while the pulse in the right carotid was unaffected, that in the right wrist was imperceptible. After death, that anomalous distribution was found in which the right subclavian is the last branch of the arch. Passing between the aneurism and the spine, it had been compressed, while the carotid was unaffected.

§ Wardrop, *op. cit.* p. 162; Og'le, in *Path. Soc. Trans.* vol. x. p. 103; Bel-
lingham, *On Diseases of the Heart*, p. 601; Allan Burns, *op. cit.* p. 68.

(hand and fore-arm, or face and scalp); pressure on the recurrent nerve, to laryngeal symptoms; on the phrenic nerve, to spasmodic action of the diaphragm; on the trachea, to stridulous respiration, &c.; but much caution is necessary in estimating these symptoms, which are common to thoracic aneurisms as well as cervical.

It will be seen from this extremely imperfect sketch, how difficult it is to determine, when an aneurism is situated low at the root of the neck, what or how great a part of the arterial tube is involved. The importance of a precise diagnosis consists in the fact that four great operations are recommended for such aneurisms, and that their applicability depends entirely on the limitation of the disease. 1. If the subclavian or carotid were alone involved, a ligature applied to the innominate artery would be analogous to the treatment adopted in other parts of the body. 2. If the aneurism were seated far down the subclavian on the right side, it might be possible to tie the first part of the artery itself, as indeed was done by Mr. Liston. 3. If the root of the carotid alone were implicated, a ligature on the distal side of the tumour (known as Brasdor's operation) might prove successful. 4. In aneurism affecting the innominate artery, it has been proposed to extend this method, and tie both the subclavian and carotid; while if the arch of the aorta were diseased, most surgeons would think any operation unjustifiable.

Assuming that the question of performing any of these grave operations is not entertained till a patient trial of judicious medical and dietetic means has been made and failed, and that a thorough examination of the chest has given reasonable assurance of immunity from disease of the heart, lungs, and aorta, I will endeavour to state as succinctly as possible the conclusions to which I have been brought by observing a few cases, and reading the account of a good number.

1. The ligature of the innominate artery is an operation which has hitherto, except in a single case, only precipitated the fatal result impending over the disease, and which appears to afford less prospect of cure than the methods of general treatment which have been above indicated. But if these are obviously insufficient, it may in appropriate cases recommend itself to some surgeons.* It should never be performed, however, unless

* See below, Ligature of the Innominate Artery. Having regard to the successful issue of Dr. Smyth's case, it becomes a serious question whether the

the artery can clearly be felt healthy behind the sterno-clavicular joint;* or the tumour is so plainly limited as to afford a very reasonable hope that it will be found so. In cases of tubular enlargement of a long tract of artery in the neck, it is worse than useless to expose an artery which will probably be found so diseased as either to prevent the operator from the attempt to tie it, or to give way and occasion fatal bleeding within a few hours if it is tied.

2. The ligature of the first part of the right subclavian artery is an operation which cannot be described in more favourable terms than that of the innominate, as far as its results go; but the indications are, perhaps, rather less perplexing, since a clear space ought to exist between the tumour and the trachea. Viewing, however, the anatomical difficulties of the operation, the doubt that must always exist whether the artery will be found healthy enough to unite as firmly as is necessary to bear the impact of so great a column of blood, and the great liability to secondary hæmorrhage from the neighbourhood of large branches, the operation seems so unpromising that most surgeons would prefer the plan by manipulation devised by Sir W. Fergusson, or galvano-puncture, dangerous and uncertain as these measures must be allowed to be. If this operation be attempted, the surgeon should take into mature consideration the possibility of securing, at the same time, some of the large branches.

3. Brasdor's operation for securing the artery on the distal side of the tumour is applicable, and applicable almost exclusively, to aneurisms affecting the lower part of the common carotid artery; in which, from the equality of the radial pulse on the two sides, the distinct limitation of the tumour, the freedom from œdema of the arm and hand, and the absence of murmur in the aorta or subclavian, there is reason to believe that the affection is confined to the common carotid. In such cases, it would be reasonable to commence the treatment by applying digital pressure to the artery, in the position in which it is intended afterwards to tie it.

4. The double distal ligature, *i.e.* the ligature of the subclavian and carotid for aneurism of the innominate artery, has

carotid and vertebral should not be secured in the same operation in which the innominate is tied. Further experience is necessary on this point.

* If the shape of the bones or joints is altered, it is clear that the aneurism arises in the thorax.

been performed in a few cases, of which a list will be found in a subsequent page. As far as the experience of these cases enables one to judge, it appears that this operation is justifiable in favourable cases of aneurism in which the innominate artery is believed to be alone implicated, and in which the main symptoms are those of pressure on the trachea and œsophagus.

In the sections which describe the treatment of aneurism by manipulation, by coagulating injections, and by galvanopuncture, the reader will find sufficient data to guide him in forming an opinion as to the propriety of using those measures in any given case of aneurism in the neck.

Brasdor's method will be found described on a subsequent page, together with other operations on the common carotid artery. It remains only to describe the operations on the first part of the subclavian and on the innominate artery.

In order to secure the *first part of the right* subclavian artery*, as in the operation on the innominate, the root of the carotid is to be exposed and traced down to the bifurcation. The external incisions and superficial dissection are therefore the same for both operations. An incision should be made along the upper border of the clavicle, a director passed under the sternal border of the sterno-mastoid muscle, and the whole or the greater part of the muscle separated from the sternum and clavicle. An incision should also be made upwards along the inner edge of the muscle, and the whole flap containing the divided muscle should be reflected outwards. The sterno-hyoid and sterno-thyroid muscles now come into view, and may be drawn aside with a blunt hook, or cut across. This will expose fully the sheath of the carotid vessels—the internal jugular vein on this side inclining away from the artery, so as to leave an interval in which the pneumo-gastric nerve is to be found. If now the operator desires to secure the first portion of the subclavian, he must remember that the only part of it sufficiently free from important relations to admit of the operation is the small portion bounded by the pneumo-gastric nerve on the inner side, and the thyroid axis with the phrenic nerve on the outer side. The former nerve therefore is to be taken as the guide; and, the carotid artery having been traced down to the bifurca-

* The left subclavian has been tied once in the first part of its course with a fatal result by Dr. J. K. Rodgers of New York. I have not been able to procure any details of the operation (see Mott's *Velpeau*, vol. ii. 365).

tion of the vessels, the subclavian is to be followed outwards till the pneumo-gastric nerve is recognised by the finger. The ligature will then be most readily passed with a probe curved abruptly, or a needle more bent than usual, introduced from before backwards.

If, on the contrary, *the innominate* is to be tied, the operator must follow down the line of the carotid artery into the thorax, when he will find the end of the vessel behind the sterno-clavicular joint, and must get the ligature round it as best he can—perhaps the most difficult part of the whole operation, since great veins lie close to the artery, the slightest wound of which may give rise to fatal hæmorrhage, and the parts are probably quite out of sight.

On the dead subject, the innominate may be reached without any such extensive dissection, by exposing the root of the trachea with a sufficient incision, and running the finger down it into the thorax, where the artery will be felt crossing the air-tube obliquely; but in the living body I should think the greater freedom and better view of the parts obtained by the division of the muscles at the root of the neck would render the operation above described preferable.*

The innominate has also been reached from the front, by removing the end of the sternum and the sternal end of the clavicle. Two cases were operated on after this manner by Dr. Cooper of San Francisco,† the aneurism affecting in both cases the carotid and subclavian arteries, while in one at least the end of the innominate itself was diseased. The first patient died a few days after the operation, his death being hastened, it is said, by disease of one kidney. In the second case hæmorrhage had occurred, but the patient was going on well, when he tore off the bandages from his wound, with the intention of destroying himself, and perished of hæmorrhage on the thirty-fourth day.‡

The innominate artery has now been tied more than a dozen times. Mr. Erichsen tabulates thirteen cases, including the last published case under the

* It is usual in speaking of the ligature of the innominate artery to describe various contrivances for carrying a ligature round it. I have not found on the dead subject that they are superior to the simple aneurism-needle, nor have I seen any case in which they have been used on the living. Mr. Syme, in speaking of the ligature of the common iliac artery, says that, in his judgment, 'the simplest form of needle is the best' (*Obs. in Clinical Surgery*, p. 169).

† *Amer. Journ. of Med. Sc.* Oct. 1859.

‡ Erichsen, *Science and Art of Surgery*, ii. 8.

care of Smyth. M. Le Fort,* who omits one of Mr. Erichsen's cases, adds two others said to have been operated on by Bugalsky, which Mr. Erichsen discredits. There is likewise another operation which is said to have been performed by Pirogoff, and all these cases are received by Dr. Pilz. If we received all these as authentic, we should have sixteen or seventeen operations—one of which only proved successful. In that case † the innominate and carotid were tied simultaneously by Dr. Smyth of New Orleans, for subclavian aneurism, referred to an injury received about three months before. Secondary hæmorrhage occurred fourteen days afterwards. The wound was then plugged with small shot and the ligature on the innominate was 'pulled away, even against some resistance.' The tendency to hæmorrhage was kept in check for more than a month by the compression of the shot, when it recurred with great violence. The vertebral artery was then tied. This was followed by marked decrease in the circulation of the arm, and the brachial artery became occluded. The radial pulse, however, returned after a few days. All went well after this last operation, and the patient at the date of the report (four months after operation) was perfectly well, except that he had not completely regained the use of his arm.

In four cases the artery has been exposed, but found so diseased that the operator has not dared to tie it. In one of these cases (Porter's) the disease afterwards underwent a spontaneous cure.

A case is reported in vol. xix. of the *Bulletin de l'Académie Imp. de Méd.* p. 454, in which M. Peixoto of Brazil, is said to have tied the innominate with a 'ligature d'attente,' removed on the twelfth day, for hæmorrhage from an erectile tumour of the ear, coming on before the separation of a ligature which had been placed on the common carotid. The patient recovered completely. There is no proof, however (as M. Velpeau, the reporter for the Academy, observes), either that the innominate was really tied in this case, since the ligature might have been placed under the root of the carotid, or if tied, that it was obliterated.

A case should also be referred to, under the care of Dr. Porter of Dublin, ‡ in which acupressure was used to the axillary artery, and followed by pressure on the innominate, by means of a screw instrument with two blades, one blade resembling an ordinary aneurism-needle, and the other blade made to screw down on to the former. This was kept for three days under the artery, and then removed. Pulsation immediately returned in the tumour, which soon afterwards burst, and the patient died.

The operation on the first part of the subclavian has been hitherto uniformly fatal. Eleven cases are on record; § the cause of death was hæmorrhage in every case which survived long enough. In one (Mr. Partridge's) the patient died on the fourth day, from pleurisy and pericarditis. If the surgeon should trust himself to perform this operation, it would undoubtedly be his duty, remembering Dr. Smyth's and Mr.

* *New Syd. Soc. Biennial Retrospect* for 1865-6, p. 351.

† *New Syd. Soc. Biennial Retrospect* for 1865-6, p. 346; from the *New Orleans Med. Record*.

‡ *Dublin Quarterly Journal*, November 1867. § Erichsen, op. cit. ii. 84.

Liston's cases, to endeavour to guard his patient from secondary hæmorrhage by tying the carotid and vertebral at the same time. But it must always remain in the highest degree doubtful whether such an operation would not be more dangerous even than the disease it is intended to cure. Sir W. Fergusson has proposed to treat aneurism at the root of the neck which resists less heroic measures, by amputating at the shoulder-joint, trusting that the (distal) ligature of the axillary artery on the face of the stump would cure the aneurism now that the limb is removed, and so no need exists for a collateral circulation. The only published case in which this operation has been tried is Mr. Spence's, which is added to Mr. Poland's paper on indirect digital compression for the cure of subclavian aneurism (*Med.-Chir. Trans.* vol lii. p. 306). In that case the limb was threatened with gangrene, which made the indication for amputation more plain than it would have been in any ordinary case. The patient survived the operation about four years; the cause of death was not exactly known, but it appears to have been due to the growth of the aneurism. The latter was of the tubular variety. It diminished in size after the amputation, but there was no proof of any coagulation of its contents. The operation must be a most dangerous one to a patient labouring under disease of the great vessels, and the cure of the disease by it highly doubtful. In one case (referred to on p. 555, note), subclavian aneurism has been successfully treated by digital pressure above the tumour, but there were peculiar anatomical conditions in that case which cannot be expected to be again met with.

Ligature of the *vertebral artery* was performed by Dr. Smyth of New Orleans, for secondary hæmorrhage, in the case of ligature of the innominate and carotid above mentioned. The operation is performed in the following manner.*

The head of the patient being thrown backwards and turned slightly to the left, an incision two inches long was made from a little above the clavicle along the posterior border of the sterno-mastoid muscle. The edge of this muscle having been exposed and drawn aside, the prominent anterior tubercle of the transverse process of the sixth cervical vertebra was readily felt, and taken for a guide—the artery lying vertically below it. A layer of fascia was divided, some loose cellular tissue with lymphatics and the ascending cervical artery were pulled to the inner side; the scalenus anticus and longus colli muscle were separated from each other close below their insertion into the tubercle, when the artery and vein became visible. The vein was drawn to the outer

* This method of operating will be found described in Mott's *Velpeau*, vol. ii. p. 229.

side (a point of importance according to Dr. Smyth), and the needle was passed round the artery from without inwards. Dr. Smyth remarks that when the artery enters the foramen in the fifth transverse process, it is more readily found. In one case which he dissected he found it entering the foramen of the seventh vertebra. In Dr. Smyth's case the operation was much facilitated by the empty condition of the vessels consequent on the previous hæmorrhage.

Dr. Parker of New York also tied the vertebral artery simultaneously with the carotid and subclavian (its first part) in a case of subclavian aneurism. The patient died of hæmorrhage, and on post-mortem examination it was found that both the central end of the subclavian and that of the vertebral were opened by ulceration.*

BRASDOR'S METHOD OF TREATING ANEURISM.

Brasdor was, it is said, the first to propose the operation which has ever since gone by his name, viz. the ligature of an artery affected by aneurism on the distal side of the tumour, or that farthest from the heart, instead of the usual plan of tying it between the heart and the tumour. Brasdor, however, has left no written account of his proposition, nor did he ever put it in practice. It was renewed by Desault, and he has left us a notice of it in his works.† The first person to act upon the suggestion was Deschamps, in a case of femoral aneurism; but his operation was undertaken on such mistaken principles, and was conducted so unsuccessfully, that little use can be made of it. Sir Astley Cooper‡ tied the femoral artery below an aneurism in the groin, which appeared to him to have extended so far up as to render the application of a ligature above the tumour impracticable. It seems, however, from the terms in which this operation is spoken of, that it was only intended as a temporary expedient, and that Sir A. Cooper expected from it merely such a diminution in the size of the tumour as would render it afterwards possible to apply a ligature in the ordinary way. In this he was disappointed, for the tumour continued to extend upwards, and burst under the peritonæum.

With the resources that modern surgery possesses, and, it may be added, with the knowledge we now possess of the very grave dangers attending on ligature of the large vessels, such operations as those above alluded to would be universally repu-

* *Am. Med. Times*, March 5, 1864; *Am. Journ. Med. Sc.* 1864, p. 562.

† *Œuvres chir.* vol. ii. p. 568.

‡ Hodgson, op. cit. p. 301. Mr. James of Exeter performed a similar operation on the patient in whom he afterwards secured the aorta, and attributed to the distal ligature of the femoral a certain amount of diminution of the tumour. —*Med.-Chir. Trans.* vol. xvi. p. 1.

diated. There is no such reasonable probability of curing an aneurism of any large artery of the limbs by distal ligature as would justify a surgeon in exposing his patient to the risk of the operation.

There is, however, one situation in which the operation has been successfully performed, and in which it will be perfectly justifiable to repeat it, at least until some more certain and safe means of cure can be suggested; viz. in aneurisms of the carotid artery at the root of the neck. Mr. Wardrop* was the first to show the practicability of this proceeding; and he operated successfully on a carotid aneurism of recent origin in a lady aged seventy-five. To him also must be conceded the merit of showing the difference in principle between the operation as practised upon the carotid and upon the arteries of the limbs. The difference depends simply upon the fact that no branches are given off by the carotid artery in any part of its course; so that, for this purpose, the whole of the vessel may be regarded as part of the aneurismal sac, and a barrier at any part of the artery will stop the circulation through the tumour. This at least is the case if the aneurism be not situated so near to the subclavian (on the right side) as to share in the circulation of that vessel; but such a tumour would be almost as much an aneurism of the subclavian as of the carotid. On account of his success in this instance, and his work written to recommend this form of operation,† Mr. Wardrop's name is frequently associated with the method of distal ligature.

Wardrop pointed out plainly the difference in the method of Brasdor as applied to carotid and other aneurisms—viz. that in the former no branch intervenes between the aneurism and the ligature; and he related four cases of carotid aneurism so treated, ‘proving indisputably,’ as he said, ‘that the future growth of an aneurismal tumour may be arrested, and its parietes consolidated, by placing a ligature on an artery on the *distal* side of the sac, when no branch intervenes between the sac and the ligature’ (op. cit. p. 53). He goes on from this point, which he believes himself to have demonstrated, and the demonstration of which is I think quite satisfactory, to state that in his opinion the same method may also be pursued in cases where the artery is differently situated, *i.e.* where branches do intervene between the aneurism of the ligature, as in the cases where the carotid artery

* *Med.-Chir. Trans.* vol. xiii. p. 217.

† *On Aneurism.* London, 1828.

alone, or the subclavian and carotid simultaneously, are tied for aneurism of the innominate. But here I cannot think Mr. Wardrop's facts or reasonings are at all conclusive. He gives one case (that of Mrs. Denmark) in which he tied the subclavian artery for innominate aneurism, the carotid being so compressed that he judged it to be impervious, which, however, it was not. The patient survived some time, and evidently derived benefit from the operation, but the disease seems not to have been really cured. Mr. Wardrop also mentions the case operated on by Mr. Evans of Belper, by ligature of the carotid alone, in which the symptoms of impaction of clot in the subclavian artery were very obvious (see below, p. 578).

In the *American Journal of the Medical Sciences*, vol. xiv. p. 22, will be found a table by Dr. Norris of fifteen cases in which the carotid artery was tied on Brasdor's principle.* Of these fifteen, four are admitted to have died of the immediate effects of the operation: and to this number the third case in the table † ought certainly to be added, and perhaps the sixth also. At any rate, we shall probably not err much in representing the mortality of Brasdor's operation on the carotid artery at one-third of the number of cases. Of the fifteen cases, four only are said to have been cured by the operation. All of them appear to have been aneurisms of the carotid, unless one should be excepted (No. 5), in which the innominate was thought to be affected; but as this case recovered, the diagnosis was of course not absolutely confirmed.‡ Dr. C. Pilz has given a table of thirty-eight cases, in which, according to his classification, the carotid artery has been tied on Brasdor's method. However, the value of that table will be found to be much diminished by the fact that Dr. Pilz has mixed together cases in which the ligature of the carotid was the main operation, and which were performed strictly on the principles laid down by Wardrop, with others in which (as in Liston's and Smyth's cases) the main operation was the ligature of the trunk between the tumour and heart, and that of the carotid was merely a precaution against the reflux current. Nor is Dr. Pilz's collection by any means free from errors. Out of the thirty-eight cases twelve only recovered, twenty-five died, and in one the issue was uncertain. A careful examination of Dr. Pilz's table will, I think, convince any person that the reality of cure or even of improvement in many of the twelve cases which recovered from the operation, is not only not proved, but is highly improbable. I refer especially to the cases marked 553, 559, 564, 566, 583, 586. If we take these statistics as being correct, which we are obliged to do in the want of more

* Of which six were for aneurism, supposed to affect the carotid only; in the remainder, the innominate was thought to be the seat of the disease, though it is plain, from the dissection of cases in which death took place, that in some at least the arch of the aorta was diseased.

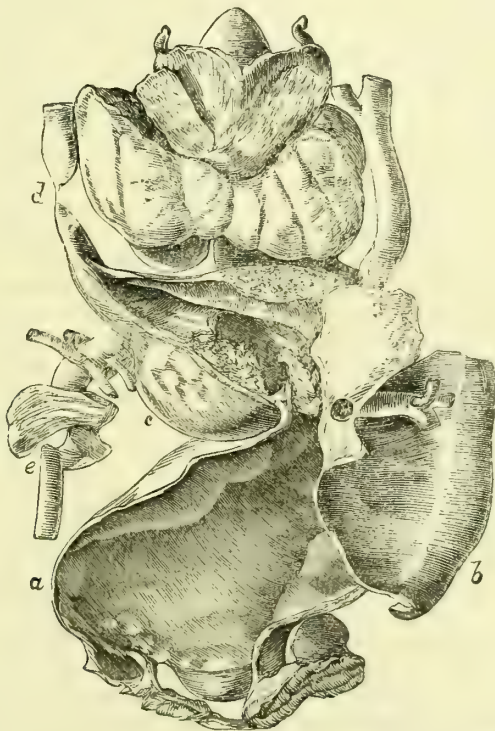
† Mr. Lambert's, quoted from Wardrop, *On Aneurism*.

‡ The last case operated on in London was under the care of Mr. Lane. The operation was unsuccessful, as the aneurism burst into the lung.—Cooper's *Surg. Dict.* 8th ed. 1861, vol. i. p. 215.

extended experience, it is abundantly plain that the risk of the operation is counterbalanced by a rational probability of success only when the aneurism is seated upon the carotid itself, and does not share in the pulsation of the subclavian. The above amount of success is, however, quite enough to justify the adoption of the method in any such case, where the attempt to tie the artery on Hunter's principle would be impracticable or even attended with unusual danger.

One circumstance, which seems to occur pretty generally though not universally in these cases, testifies very strongly to

FIG. 166.



The parts from the case in which Mr. Fearn of Derby tied the carotid and subclavian arteries for innominate aneurism. (From the preparation in the Museum of the Royal College of Surgeons.) *a*. The root of the aorta. *b*. The dilated portion of the arch divided. A portion of the inner wall of the artery is seen above, in a different light, with the left subclavian artery opening out of it. *c*. The aneurism occupying the whole length of the innominate artery, almost entirely filled with firm coagulium, through which, however, a channel is left about equal to that of the natural artery. A portion of clot is seen projecting through the mouth of the aneurism into the aorta. *d*, *e*. The carotid and subclavian arteries at the seat of ligature.

the activity of the efforts of nature to cure the disease. It is, that the pulsation in the tumour is usually not increased, but, on

the contrary, often much diminished, by the ligature of the vessel beyond it. In almost all the cases related in Mr. Wardrop's book, the tumour was observed to diminish both in size and pulsation immediately after the operation; a result which could only have been due to the rapid increase in size of the branches below the tumour, by which the course of the stream of blood was diverted from the aneurism.

Aneurism of the innominate artery and other aneurisms at the root of the neck have also been treated by the distal ligature, sometimes of the carotid and subclavian simultaneously, at others of the same arteries with an interval between the two operations; of the former, four operations are on record, of the latter three. In each class one case of cure is claimed.

Mr. Fearn of Derby * tied the carotid on August 30, 1836, and the third part of the subclavian on August 30, 1838, on account of an aneurism of the innominate artery. The patient recovered from both operations, and died four months after the ligature of the subclavian, from a cause unconnected with the operation or the disease. I append a representation of the parts, which are preserved in the Museum of the Royal College of Surgeons (Fig. 166).

It is impossible to doubt that in this case a cure temporarily at any rate has been produced by the operations employed. The doubt expressed on that point in the former edition of this work, resulted from a little ambiguity in the original description of the preparation. As the patient's death happened so soon after the apparent cure of the aneurism, it is impossible to speak with confidence as to the probability of a recurrence; such recurrence is of course always to be apprehended when a channel remains through the aneurism, and has been noticed after the apparent cure of the disease in many cases of cervical and other aneurisms. But this does not affect the main fact, which is, that the patient's symptoms were completely relieved; and especially (a point to which I would call particular attention) that the growth of the aneurism against the trachea was stopped. I think we are entitled to reckon Mr. Fearn's case, therefore, as one of cure.

Another and still more interesting case in which temporary cure resulted, was under the care of Mr. Christopher Heath, who tied the third part of the subclavian and the carotid artery, simultaneously on November 21, 1865, for an aneurism believed to be innominate.† The patient was a woman aged thirty. I have not space to describe the symptoms. It will be sufficient to say that she had had hæmoptysis, was greatly distressed by dyspnoea, and there was also some dysphagia. The diagnosis was a good deal debated at the time. Some surgeons thought the disease a pulsating cancerous tumour of the bones; many (and myself among the number) were rather inclined to believe it to be a tubular aneurism involving the aorta and innominate. Mr. Heath inclined to the belief that the affection was purely innominate. The operation was followed by great

* Fearn, *Lancet*, 1836-7, vol. i. p. 129; 1837-8, vol. ii. p. 763; and 1838-9, vol. i. p. 437. See also *Path. Trans.* vol. xviii. p. 42.

† See *Lancet*, January 5, 1867.

and evident relief to the breathing, and the tumour diminished in size, allowing a perforation which existed in the sternum, but had been previously imperceptible, to come into view. The patient survived the operation four years; but the tumour never ceased to pulsate, and she died ultimately of its rupture externally through an aperture in the upper part of the sternum involving the right sterno-clavicular joint.

The parts are in the Museum of the Royal College of Surgeons, and they show a bilocular aneurism of the aorta, the innominate being hardly if at all affected.*

In this case the benefit from the operation, and the consequent prolongation of the patient's life, were too decided to admit of any doubt, and I think furnish abundant justification for the treatment employed, in spite of an error in diagnosis, which I believe to have been inevitable. The improvement obtained would no doubt have been more permanent had the patient's habits been different; but she was a woman of most irregular life, and after the operation, had been brought in a state of intoxication into nearly every hospital and workhouse infirmary in her part of London. Here, as in Mr. Fearn's case, the relief of the dyspnoea is a very striking fact.

The following is a brief abstract of an interesting case, hitherto unpublished, of distal ligature of the subclavian for innominate aneurism. The operation was performed by M. Broca. I am indebted for the case to Mr. Heath, to whom the notes were sent by M. Broca.

The patient was a man aged fifty, who had had a pulsating tumour above the right clavicle for about a year. The sterno-clavicular joint on that side was destroyed, so that the clavicle was movable on the sternum. The disease had been diagnosed as an aortic aneurism, and he had been for some time in an asylum for incurables. He was then transferred into a surgical ward by one of the 'internes' who wished to study the case, and thus came under M. Broca's observation. He then had a fit, accompanied by convulsions on the left side, difficulty in speech, loss of memory and of general mental power, and violence. This lasted twelve days. When M. Broca examined him he found the pulse absent from the right carotid artery and its branches, and the pulse in the right radial artery, when examined by the sphygmograph, showed considerable modification, while the left radial pulse was almost normal. From these circumstances M. Broca was led to conclude that the aneurism was not of the aorta, but of the innominate, and determined to tie the subclavian beyond the scaleni, judging that the carotid was already closed by impacted clot. At this time there was noisy breathing and much dysphagia, from pressure on the trachea and oesophagus. The operation was performed on August 25 or 26, 1862. On the following day, the patient was able to breathe and swallow readily, the pulsation was already less violent, and what was very curious, the bruit de soufflet, which before the operation was with the first sound of the heart, was now with the second. The ligature came away on the twentieth day, and the wound gradually closed. After his recovery, the tumour still continued to pulsate, and was of about the same size; but it felt much more solid, and the pulsation was neither so powerful nor so superficial. The general health was perfect, and the cerebral symptoms quite disappeared. He went on perfectly well till February 1863, when he was readmitted with gangrene of the left

lung, of which he died. Up to the time of his death, the aneurism remained in the same condition. The pulse had never returned in the carotid and its branches. On post-mortem examination the carotid was found pervious, but reduced in diameter and flattened by pressure. The middle cerebral artery was plugged. The aorta was dilated to one-fourth more than its common calibre. The aneurism occupied the whole length of the innominate artery, 'communicating with the aorta by an opening about four centimetres in size' (a little more than an inch in diameter). The tumour enclosed an enormous mass of clot, in the centre of which was a cavity of the size of a small egg. This cavity communicated with the carotid by an oblique and flattened opening, and on the outer side with the subclavian. The latter artery had its normal calibre, but all its branches were much dilated. The bones of the thorax had been extensively eroded, and had at one time evidently been bathed in the blood of the aneurism. This, however, had not prevented the formation of fibrinous clot. Here again I would remark the immediate relief of dyspnoea which followed on the operation.

In order to provide the reader with proper data for forming a judgment on the important question of the advisability of the treatment of cervical aneurism by the distal ligature, I append, in addition to the above cases, the following list of references to the published cases of these operations, for which I am again indebted to Mr. Heath's kindness.

TABLE OF CASES OF DISTAL LIGATURE FOR ANEURISMS AT THE
ROOT OF THE NECK.

- I. *Aneurism of the Innominate, treated by Ligature of third part of Subclavian.*
 1. Wardrop, 1827. Died two years afterwards. Wardrop, *On Aneurism*.
 2. Broca, 1862. Died six months afterwards. Referred to in text.
- II. *Aneurism of the Innominate, treated by Ligature of the first part of Axillary.*
 - Laugier, 1834. Died one month afterwards. *Lancet*, vol. i. 1834, p. 889.
- III. *Aneurism of the Innominate, treated by Ligature of right Common Carotid.*
 1. Evans, 1828. Recovered. Wardrop, *On Aneurism*.
 2. Mott, 1829. Died seven months afterwards. Mott's *Velpeau*.
 3. Aston Key, 1830. Died in a few hours. *Med. Gaz.* vol. vi. Guthrie, *On Arteries*.
 4. Case reported by Neumeister, 1830. Died five days afterwards. Hollond, *Dublin Quarterly Journal*, February 1852.
 5. Morrison, 1832. Died one year and eight months afterwards. *Am. Journ. Med. Sc.* xix. 329.
 6. John Scott. Died. *Lancet*, 1834-5, i. 893.
 7. Dohlhoff, 1837. Died sixth day. Broca, *On Aneurism*, p. 632. *Rust. Mag.* vol. li. p. 529, 1838.
 8. Fergusson, 1841. Died seven days afterwards. *Lond. and Edin. Journ* 1841, vol. i. p. 786.

9. Porta, 1842. Died forty hours afterwards. *Porta, Alt. patol. delle Art.* p. 35.
10. Hutton, 1842. Died sixty-six days afterwards. *Dublin Journal*, vol. xxv. p. 499.
11. Vilardebo, 1843 (?) Died twenty-one days afterwards. *Arch. gén. de Méd.* 1847, p. 547.
12. Campbell, 1844. Died nineteenth day. *Lond. and Edin. Journ.* 1845.
13. Wright, 1855. Died sixty days afterwards. *Montreal Med. Chron.* April 1856.
14. Ordile of Naples. Died.*
15. Addinell Hewson, 1867. Died twelve days afterwards. *Pennsylvania Hospital Reports*, vol. i. 1868.

IV. *Aneurism of the Innominate treated by double consecutive Distal Ligature.*

1. Fearn. Carotid, August 30, 1836; subclavian, third part, August 2, 1838. Died four months after the last operation. *Lancet*, 1837, 8, 9.
2. Wickham. Carotid, September 25, 1859; subclavian, third part, December 3, 1839. Died. *Lancet*, 1839; *Med.-Chir. Trans.* 1840.
3. Malgaigne. Carotid, March, 1845; axillary, first part, October 17, 1845. Died. *Bull. de la Soc. Anat.* 1848, vol. xxiii. p. 291.

V. *Aneurism, supposed to be of the Innominate, treated by double simultaneous Distal Ligature.*

1. Rossi, 1843. Carotid and first part of subclavian. Died. *Gaz. méd.* 1844, p. 58; Broca, *On Aneurism*.
2. Cuvellier, 1859. Carotid and third part of subclavian. Died. Demme, *Spec. Chir. d. Schusswunden*, p. 210.
3. Heath, 1865. Carotid and third part of subclavian; survived four years. *Lancet*, January 5, 1867, referred to in text.
4. Hutchinson of Brooklyn, 1866. Carotid and third part of subclavian (the subclavian is said not to have been really tied; Erichsen, *Sc. and Art of Surgery*, vol. ii. p. 59). Recovered from the operation, but died from suffocation on the forty-first day. *Brit. Med. Journ.* March 30, 1867.
5. Maunder, 1867. Carotid and third part of subclavian. Died. *Path. Soc. Trans.* xix. 93.
6. Sands of New York, 1868. Carotid and third part of subclavian. Recovered from the operation. Disease not cured. *Am. Journ. Med. Sc.* April 1869, p. 568.

Mem. In this class, the nature of the cases varied considerably. Rossi's and Hutchinson's were really innominate; Cuvellier's was subclavian; Heath's and Maunder's were aortic; Sands' remains uncertain.

VI. *Aneurism of right Carotid, treated by Distal Ligature.*

1. Wardrop, 1825. Recovered. Wardrop, *On Aneurism*.†
2. Lambert, 1826. Died. Wardrop, *On Aneurism*.
3. Bush, 1827. Recovered. Wardrop, *On Aneurism*.
4. Lane, 1852. Died. Art. 'Aneurism,' Cooper's *Surg. Dict.* 8th edition, vol. i. p. 215.

* This operation was performed about the year 1859, and was communicated to me verbally by the operator.

† Wardrop claims to have tied the carotid in a second case of this nature, but as the artery was found completely pervious after death, and with no trace of ligature, it is probable that a mistake was made in the operation. The case is therefore not reckoned here.

VII. *Aneurism of left Carotid treated by Distal Ligature.*

1. Montgomery, 1829. Died. Guthrie and Broca.
2. Colson (de Noyon), 1840. Recovered. *Bull. de l'Acad. de Méd.* September 1841. Robert, *sur les Anév. sus-claviculaires.*

VIII. *Aneurism of the Subclavian, treated by Ligature of the Axillary.*

1. Dupuytren, 1829. Died. *Lond. Med. Gaz.* vol. iv.
2. Canton, 1863. Died. *Med. Times and Gaz.* January 2, 1864.

IX. *Aneurism of first part of Subclavian treated by Ligature of third part and Injection.*

Pétriquin, 1853. Died. Broca, p. 419, *Gaz. hebdomadaire*, vol. i. p. 192.

X. *Aneurism of Subclavian treated by Ligature of Carotid.*

Butcher, 1863. Died fourth day. Butcher, *Op. Surg.* p. 855.

XI. *Aneurisms in which the Carotid was tied, and which proved to be Aortic.*

1. Tillanus. Lived five months. Velpeau, *Méd. Opér.*
2. Rigen, 1829. Lived three months. Died of hernia. Velpeau, *Méd. Opér.*
3. O'Shaughnessy. Died seven days afterwards. Galvano-puncture also. *Dub. Med. Press*, October 5, 1842.
4. Knowles, 1867. Died of apoplexy. *Lancet*, June 13, 1868.

If now it is necessary to express an opinion on a subject which must be allowed to be hardly ripe as yet for a deliberate judgment, I would say that I entertain no doubt of the propriety of performing what I have been in the habit of regarding as peculiarly Wardrop's operation—viz. the distal ligature of the carotid artery in aneurism involving only the root of the carotid. This operation Wardrop himself performed, and induced others to perform, and (in the passage quoted on p. 571) he clearly showed that it could be practised with reasonable prospect of cure in aneurisms where there would be no branch between the tumour and the ligature. Wardrop's name is also associated with the other method of applying the distal ligature, viz. that where one or more branches do intervene between the tumour and the ligature, but in my opinion with less reason. He did indeed suggest the plan, and in one case he performed an operation somewhat on this principle; but it was in itself imperfect; for, though Wardrop saw the necessity of securing both the main trunks in cases of innominate aneurism, in this instance he tied only the subclavian, being deceived by the absence of perceptible pulsation in the carotid into a belief that that artery was occluded. In this case, in Broca's case above quoted, and in Evans's case cited by Wardrop, benefit seems to have resulted from the ligature of one artery only; but it should not be forgotten that in Wardrop's case other treatment was

also adopted (copious venesection and antiphlogosis) ; in Evans's the apparent cure was probably due to impaction of clot ; and in Broca's there was amendment, but certainly no cure. In all the other cases in which one artery only has been tied, I cannot see that any good has been done.

There remains the question of double distal ligature. Here, again, I think there is no decisive proof of permanent cure, but Fearn's and Heath's cases, were, to say the least of it, highly encouraging ; the latter even showing that in aortic aneurism the operation may not be inapplicable—though I would hardly take it on myself to recommend such a proceeding in a case of aneurism known to be aortic. My opinion on this matter is, in fact, exactly as it is here stated from the report of the debate at the Royal Med. and Chir. Soc., on the reading of Mr. Heath's case there :*—‘ Considering the great difficulty of diagnosis, the risk of finding the arteries diseased where exposed for operation, the great likelihood of serious disease in the aorta or even the heart also, and the possibility of spontaneous cure, or cure by appropriate regimen, it seems prudent not to undertake these operations without the gravest consideration, and in circumstances which can but rarely present themselves. Perhaps the best indication for operation would be the relative amount of pressure on the trachea compared with that of the general symptoms. That is, when the patient is otherwise in moderately good health, but suffers much from dyspnœa, and appears likely to die soon from rupture of the aneurism in this direction, the question of arresting it by ligature of the arteries of the right side might be considered, but in any case it must be regarded rather as palliative than as curative.’

Old operation for carotid aneurism.—The treatment of aneurism at the root of the neck, at least when it follows a wound, has been lately successfully carried out by Mr. Syme on the old method, by laying open the tumour and searching for both ends of the vessel. An abridged account of this daring operation is appended ; the reader, however, can have no idea of the risks and difficulties of such a proceeding without perusing the fuller account in the original, and even then his idea will be but a faint and imperfect one.

* *Lancet*, Jan. 5, 1867.

The operation performed by Mr. Syme may be thus summarily described.* The patient had been stabbed in the root of the neck about two months before, and an aneurism had formed, connected with the lower part of the left common carotid. This had been advancing rapidly, under compression applied to the tumour, so that it was necessary to do something. Mr. Syme made a small opening into the pulsating tumour with a bistoury, and then passed in his finger so as to plug the puncture, and felt about till he got upon the spot where pressure controlled the pulsation, and where, therefore, the opening lay. Keeping this point firmly compressed, he laid the sac freely open, and sponged out the clots. A smooth serous surface was exposed, with no trace of artery or vein. The skin and sternal portion of the sterno-mastoid having now been divided by a transverse incision (pressure being still kept upon the opening with the finger), the edge of the slit in the artery which lay under the finger was caught with catch-forceps, and the vessel drawn towards the trachea; it was then carefully scratched with a knife, till the arterial coat was brought into view on the external edge, and a ligature passed round it above the aperture. The same proceeding was repeated below the opening; and now the finger could be withdrawn without the tremendous gush of blood which had before followed its displacement.

It is clear that such an operation as this can be successfully performed (that is to say, performed without instant death resulting) only by a surgeon who possesses a large share of that fertility of resource and dexterity in operating which Mr. Syme showed in so great a degree in this case. On the general question, as to whether a case like the above ought to be treated on Brasdor's plan, or as Mr. Syme treated it, it would be rash to affect to give a positive opinion; much would depend upon the confidence of the surgeon in himself. If he felt able to carry out to a successful conclusion so difficult an operation, he would probably imitate Mr. Syme's practice; if not, he might try the distal ligature of the carotid. Should Brasdor's operation fail to check the progress of the tumour, the old operation might be tried, and even a faint prospect of life might remain to the patient from an attempt made to secure the artery after the aneurism had burst.

The above operation indicates so clearly the steps that should be taken in securing the carotid on account of a wound, that no further description of that proceeding is necessary.

ANEURISMS IN THE UPPER PART OF THE NECK, THE ORBIT, AND THE CRANIUM.

Aneurisms above the root of the neck will be found to affect either the common carotid just at its bifurcation, or the arteries of the orbit or cranium. The diagnosis in either of the two former situations can generally be established satisfactorily;

* *Observations in Clinical Surgery*, p. 154.

but few things are so difficult as to distinguish from each other the various diseases which may cause pressure on parts of the brain, or disturbance of the cerebral functions.

The occurrence of dilatation at the upper end of the common carotid artery in a slight degree is natural; and this natural dilatation is comparatively often so far increased that an aneurism results. It is an old observation, that the carotid is the only form of surgical aneurism which is equally frequent in both sexes, if it be not even more common in women. The diagnosis of aneurism situated in any part of the neck, above that portion of the carotid which lies in the immediate vicinity of the subclavian, cannot present any especial difficulty if the sac is formed and the pulsation distinct.* The proximity of the tumour to the air-passages and to the nerves which supply the larynx may cause dyspnœa, hoarseness, or even loss of speech, nausea, and perhaps impairment of appetite. There will also be giddiness, and trouble in the head; and perhaps pain, numbness, or other nervous phenomena over the head and face.† These symptoms call for decisive and efficient surgical treatment.

Aneurisms situated within the orbit are usually supposed to be of the 'anastomotic' variety; but the evidence on this point is far from conclusive. Mr. Busk ‡ has shown that many, at any rate, are of the ordinary traumatic variety; and Mr. Nunneley, in his papers on the subject, which give the result of the most extensive experience in this particular which has fallen to any individual, since no less than seven cases have been under his own care, goes so far as to question entirely the correctness of the common opinion, founded on Mr. Travers's case; and believes that all the aneurisms have been of the ordinary spontaneous or traumatic kind, except those which have spread into the orbit from a nævus of the face.§ Whether

* A case of ruptured artery is mentioned on p. 421, in which much difficulty was at first experienced in forming a diagnosis.

† See the account of Sir A. Cooper's case, *Guy's Hospital Reports*, vol. i. p. 53.

‡ *Med.-Chir. Trans.* vol. xxii. p. 123.

§ Haynes Walton (*Surg. Diseases of the Eye*, 2nd ed. 1861, p. 230) relates a case of congenital tumour protruding the eye, and causing slight pulsation and 'an arterial souffle not heard on the other side.' Crying greatly increased the protrusion, and the vascularity of the conjunctiva, which was always considerable. It was diagnosed by himself and colleagues to be aneurism by anastomosis. The carotid was tied with perfect success.

all the cases have been so or not, the general correctness of Mr. Nunneley's opinion is not to be impugned, that *most* of these cases (and probably Travers's among them) were common aneurisms.* Both the symptoms and the history prove this. Mr. Nunneley's arguments are these: aneurism by anastomosis comes on gradually, generally in early life, as a result of the growth of a congenital nævus; aneurism of the orbit very suddenly, often as the result of a blow, and almost always in advanced life:—aneurism by anastomosis occurs in the subcutaneous tissues; aneurism of the orbit generally in the deepest part of the cavity:—aneurism by anastomosis involves all the neighbouring vessels, arteries and veins, in active disease; aneurism of the orbit is generally limited to a single part, or if the neighbouring vessels are dilated, they seem only enlarged from obstruction:—ligature of the trunk of a vessel leading to an undoubted aneurism by anastomosis is an extremely unsuccessful operation; in aneurism of the orbit, a very successful one:—finally, the cases dissected have turned out to be common aneurism.†

So far Mr. Nunneley argues, and to my mind very cogently, against the view of the pathology of this disease which ascribes the symptoms to aneurism within the orbit. A further question of much interest is raised by Mr. Nunneley's papers ‡ as to the position of the disease. The prominence of the eye and the pulsation of the orbit naturally led to the conclusion that the tumour lay in that cavity; but Mr. Bowman's case, referred to below, shows that all the symptoms of 'orbital aneurism' may be produced by disease situated in the cavernous sinus, and, in one

* This is important, since the success of Travers in tying the carotid has been used, under the assumption that his case was aneurism by anastomosis, to enforce the recommendation of a similar operation in cases of aneurism by anastomosis on the scalp—an operation by which several lives have very probably been sacrificed.

† See Mr. Nunneley's account of the dissection of a case under his care which proved fatal, in *Path. Soc. Trans.* vol. xi. p. 8. I may observe, that the whole of the ophthalmic artery and its branches are represented in the drawing which accompanies Mr. Nunneley's description, as dilated, which brings the case somewhat near to cirroid aneurism. I do not understand how Mr. Nunneley accounts for this dilatation by saying it is the result of obstruction. Such obstruction might act on the artery behind, but surely not in front of the aneurism. Guthrie (*Operative Surgery of the Eye*, p. 168), in referring to the dissection of a case, merely says that he found 'true aneurism of the ophthalmic artery of both sides.'

‡ *Med.-Chir. Trans.* vol. xlii. pp. 183, 4: vol. xlviii. p. 15.

of Mr. Nunneley's own cases, examined after death, nearly four and a half years after ligature of the carotid, there was found a cured circumscribed aneurism of the ophthalmic artery in the sella Turcica (*Med.-Chir. Trans.* xlviii. 29), the vessels in the orbit being of very small size. Mr. Nunneley believes that in the great majority of cases of protrusion of the globe, the cause is pressure on the venous channels behind the orbit; and this view seems the most probable one. It seems that common sacculated aneurism of the ophthalmic artery (or possibly of the end of the internal carotid) follows after an injury, and is accompanied by perceptible aneurismal pulsation and common aneurismal bruit; arterio-venous aneurism may also be thus produced, but will present probably a different kind of pulsation and bruit;* but protrusion, bruit, and pulsation may all be produced more gradually by the numerous causes which may lead to obstruction of, or pressure upon, the great vessels in the cavernous sinus.

The diagnosis of anastomotic aneurism in Travers and Dalrymple's cases rested on the presence of soft compressible thrilling tumours in various parts of the eyelids, which presented a more distinct pulsation when pressure was made on them. It is most probable that these were merely collections of veins enlarged by pressure, and transmitting pulsation from the aneurism lying beneath them.†

Aneurism may also affect either the internal carotid artery, in its bony canal or in the cavernous sinus, or one of the arteries of the brain. The symptoms of aneurism affecting the internal carotid in the sinus are mainly of three kinds: (1) the symptoms of aneurism; (2) the symptoms of pressure on the orbital nerves; (3) those of disturbance of the cerebral circulation.

(1) In a well-marked case the symptoms of aneurism will come on rapidly, very likely after a blow or other injury; there will be, perhaps, a sharp crack heard, followed by a sawing or rasping noise. This sound will be perceived by the stethoscope applied to the head or neck, more plainly on the affected than

* A case of arterio-venous aneurism in the cavernous sinus, under M. Nélaton's care, which was diagnosed as an aneurism of the ophthalmic artery, is shortly referred to by Dr. Holmes, in the *Am. Journ. Med. Sc.* July 1864, p. 46. The case is probably reported more at length in some of the French journals.

† See a paper by Mr. Hart, *Lancet*, March 15, 1862, on a case of arterio-venous aneurism in the orbit cured by ligature of the common carotid artery.

the sound side, and will cease at once on making pressure upon the common carotid on the side of the disease. If the disease is limited to the part of the artery contained in the sinus, no tumour will be perceptible externally.* (2) The first symptom of pressure upon the orbital nerves is either internal strabismus, from paralysis of the sixth nerve; † or ptosis, with external squint and dilated pupil, from pressure on the third nerve; ‡ or loss of sensation in the parts supplied by the supra-orbital nerve.§ Sight on the side of the disease is usually not affected; sometimes, however, objects are seen double, or there is more or less indistinctness of vision, the consequence, probably, of the dilatation of the pupil. These symptoms of pressure on the orbital nerves may exist singly, or in various combinations. (3) The symptoms of cerebral disturbance do not seem greater in a moderately early case of this affection than in an aneurism of the common carotid: headache, giddiness, inability to stoop, frightful dreams, &c. There is no pressure on the brain, since the growth of the tumour is opposed by the dura mater. It seems possible that the aneurism might grow through this membrane, and cause softening of the base of the brain; but I have not met with such a case.

With such a combination of symptoms, then, the diagnosis of aneurism may reasonably be made; and the case may justifiably, in the present state of our knowledge, be treated as such.

Such a case was the following, which occurred under the care of Mr. Coe of Bristol and Dr. Swayne.¶ The patient was a woman, aged fifty-five. The disease was attributed to a blow five months before, after which she complained of a buzzing and beating noise in the head, which at the time of the account she likened to the puffing of a steam-engine, heard more distinctly with the left than the right ear, and accompanied by a continuous sound, like low thunder, emanating from a spot near the posterior superior angle of the right parietal bone. She could not lie down in bed, and was troubled with frightful dreams. There was no bruit in the heart or great vessels, but a most distinct one in the neck and over the whole surface of the head, especially the left petrous bone; pressure on the right carotid had no influence over the sound, but on the left carotid caused it to cease immediately. On auscultating the right carotid carefully, its pulsation could be separated from the bruit, which was also louder on the left side. The left eye squinted a little, and she saw double, one thing by

* It would seem from Mr. Nunneley's cases that in some of these aneurisms in the sinus, or even more internal, there may be pulsation and fulness in the orbit. I have seen such aneurisms, however, unaccompanied by any orbital symptoms.

† *Assoc. Journal*, 1855, p. 1067.

‡ *Path. Soc. Trans.* vol. xii. p. 61.

§ *Id. ibid.*

¶ *Assoc. Journal*, 1855, p. 1067.

the side of the other. No tumour could be perceived externally. The left carotid was tied on Dec. 11, 1851; the bruit ceased; a gentle continuous murmur followed (ascribed by Mr. Coe to the flow of blood through the tumour from the anastomosing branches); this ceased in about five hours, and all the symptoms subsided. The woman was cured, and, as I was informed by Mr. Coe, remained well about ten years afterwards.

In deciding, however, on the treatment of orbital aneurism the surgeon should not be in a hurry to recommend any operative measures, unless clearly indicated by the symptoms of the case before him. Mr. Erichsen* refers to two cases in which the symptoms of orbital aneurism spontaneously disappeared, and a case which occurred under Mr. Bowman's care,† must be kept in mind, as showing that the diagnosis cannot be regarded as certain.

In that case many of the above symptoms were present—severe pain in the head, after an accident, aggravated by stooping; disturbed sleep; a beating noise in the head, compared to a steam-engine; a loud bruit, synchronous with the pulse; troubled vision: protrusion of the globe of the eye, and pulsation in the orbit strong enough visibly to lift the fingers. The carotid artery was tied, and the bruit ceased, but recurred, though not so loud, eight days afterwards. The patient died of secondary hæmorrhage, when it was found that the arteries were quite healthy; and the only diseased appearance was in the ophthalmic vein, cavernous, circular, transverse, and superior petrosal sinuses, which were filled with coagula. The pressure on the carotid artery in the sinus must have produced the bruit, the obstruction to the return of blood by the veins of the orbit, the protrusion of the eyeball, and the congestion of the parts around it; while the pulsation perceptible in the orbit is attributed by Mr. Hulke, to whom we are indebted for the report of the case, to the same cause. 'Each diastole of the ophthalmic artery,' he says, 'must have been attended by a general momentary increase of the whole quantity of blood in the orbit, because its exit through the ophthalmic vein was cut off, and the resisting bony walls of the orbit could permit a distension in front only.'

The symptoms of aneurism of one of the small arteries at the base or in the substance of the brain, are as yet quite obscure. Physicians and physiologists are busily endeavouring, by experiment and the study of cases, to decide how, from the symptoms of limited pressure or other limited lesion, to determine the precise part of the brain affected. Even if this great difficulty were got over, how are we to decide whether such

* *Science and Art of Surgery*, ii. 78. A case is related by Dr. Holmes, *Am. Journ. Med. Sc.* July 1864, p. 44, in which the patient recovered under the use of ergot of rye and tincture of veratrum. 'Whether the patient's recovery,' says Dr. Holmes, 'is due to the remedies prescribed, or independent of them, I am unable to say.'

† Streatfield's *Ophthalmic Reports*, April 1859.

limited injury depends on pressure by an aneurism, or by a tumour of a different kind, say a scrofulous tubercle? * The rapidity of the onset of the symptoms, and the variation in their severity, occasioned by different states of the circulation, seem the only peculiarities which point to aneurism, and they are excessively doubtful and delusive. We have, indeed, no means at present of diagnosing cerebral aneurism, unless a bruit could be found; and in looking over a number of cases I do not find any mention of this symptom having been looked for. In Dr. Ogle's case, however, the patient was herself conscious of 'a sawing noise' in the head. It seems, therefore, that in similar cases the head should be carefully auscultated, though it is very likely that the small size of the aneurism and of the vessel on which it is seated, and the mass of soft, ill-conducting parts that lie over it, would prevent bruit from being heard.

Treatment of these aneurisms.—Aneurisms situated in the carotid triangle of the neck must be treated on ordinary principles, digital pressure on the trunk of the vessel being used in cases where the symptoms are not very urgent, combined, perhaps, with moderate pressure over the tumour (*vide* p. 493); in severer cases, or on the failure of these measures, the common carotid artery must be tied. Besides the ordinary medical and dietetic means, and excluding a very few cases in which the surgeon might be tempted to try the effect of galvano-puncture, there are only two methods of treatment available for aneurism within the cranium or orbit, *i.e.* pressure on, or ligature of, the carotid artery. The use of digital pressure has been successful in supposed aneurism of the orbit, under the care of Gioppi and Vanzetti (p. 498); and there can be no reason why it should not succeed in such a case as Mr. Coe's. It need not give much annoyance to the patient, and can be carried on as long as the disease is either receding, or even not advancing. When its failure is certain, the common carotid artery should be secured.† It would at first sight appear better, as the disease

* See, in *Med.-Chir. Trans.* vol. xlii. p. 403, a paper by Dr. Ogle, in which he carefully endeavours to point out how, from the symptoms presented in the case there related, he might have diagnosed lesion limited to the pons Varolii. Even had he done so, however, he would have referred the lesion to pressure by a scrofulous tumour, while it was in reality an aneurism of the anterior cerebellar artery.

† In Mr. Hart's paper he attributes to the previous use of digital pressure,

is seated upon the internal carotid, to secure that vessel; but it does not seem that any advantage is obtained by leaving the stream of blood in the external carotid unobstructed. In orbital aneurism, the free anastomosis might reproduce the disease; in aneurism at the base of the brain, the danger of softening of the brain is as great after ligature of the internal as of the common carotid; while no harm ever comes from stopping the circulation through the branches of the external carotid. So that, as the ligature of the common carotid artery is an easier and safer proceeding, it is rightly performed. Dr. Morton* gives a list of thirty cases in which the carotid has been tied for 'orbital aneurism;' twenty-two of which succeeded completely and three incompletely in arresting the symptoms; two were unsuccessful, but the patient survived; three died. Injection was used successfully in two cases, and digital pressure in two.

The ligature of the common carotid in an ordinary case of aneurism, where the patient is not very stout, the aneurism not situated near the root of the neck, but towards the angle of the jaw,† and the parts healthy, is generally an easy operation. The artery can be felt, in any person not extremely stout, pulsating on the anterior edge of the sterno-mastoid muscle, at the level of the cricoid cartilage, where it first becomes superficial, after having been crossed by the omohyoid muscle—the apex of the carotid triangle. This is accordingly the place of selection for the ligature. The operation is thus performed: If the sterno-mastoid muscle is perceptible, an incision about two and a half inches in length (in a moderately stout adult) is to be made along its anterior edge, the centre corresponding to the level of the cricoid cartilage; and after the cervical fascia has been divided, which may be done freely, as no important parts are endangered, the edge of the sterno-mastoid ought to

and consequent dilatation of the collateral arteries, the entire immunity from all symptoms which his patient displayed after ligature of the carotid artery; an immunity which was certainly remarkable.

* *Am. Journ. Med. Sc.* April 1865, p. 318.

† This observation of course applies still more forcibly to the cases in which the disease is situated in the orbit, and therefore quite away from the parts operated on; but in a case where Brasdor's method was applied for a tumour at the root of the neck, and in a case of Hunterian ligature, where the tumour was lower down than usual, I remember seeing considerable difficulty experienced by the operators from the circumstance that the artery had been displaced backwards by the pressure of the tumour.

be exposed. This having been drawn a little outwards, the finger should be passed into the wound, to feel for the trachea, when the artery will be felt lying between the muscle and the air-tube. The operator must now carefully separate the cellular tissue from the sheath which covers the artery, and endeavour to raise the descending branch of the ninth nerve, which generally lies upon the sheath. This nerve, when exposed, is to be held aside with a blunt hook, while a small opening is made in the sheath of the artery; and the vessel having been cleaned by the usual manipulations, the ligature is to be passed around it from without inwards, great care being taken to keep the point of the aneurism-needle quite close to the artery, so as to avoid wounding or tying the pneumogastric nerve. The operator must remember that the *descendens noni* nerve sometimes lies within, instead of upon, the sheath of the vessels; so that, when it has not been met with after a sufficient search, the artery may be tied without seeing it; but in this case even more than common care should be bestowed in examining the vessel as it lies upon the aneurism-needle, in order to make sure that this nerve has not been included. In the course of the dissection some bleeding may occur from the sterno-mastoid artery, which is usually the descending branch of the superior thyroid, and may prove annoying to the operator unless the vessel be tied.

When the aneurism is situated lower in the neck, the operation becomes more difficult, since it is necessary to cut through a considerable mass of muscle. The artery is here situated under cover of the sterno-mastoid with the sterno-hyoid and sterno-thyroid muscles. An incision must be made along the course of the artery, viz. the line joining the sterno-clavicular articulation with the point midway between the angle of the jaw and the mastoid process, and this incision may be joined by another running outwards. The inner, or sternal, portion of the sterno-mastoid is to be cut across, and this being drawn outwards with a broad retractor, it will be generally possible to draw the two other muscles inwards, otherwise they must be divided. The sheath of the vessels will now be exposed; but there will in all probability be several large veins lying over it, which descend from the thyroid body, and on the left side of the neck the internal jugular itself inclines considerably to the front of the artery towards the thorax. The wound also is very deep, and the vessel is probably rendered relatively deeper

by the projection of the tumour. Still, by keeping the course of the vessel steadily in view, and by feeling for the trachea internally and the transverse processes of the vertebræ behind, the artery must be reached. Great care, however, is necessary in opening the sheath and cleaning the artery, since the vessel itself can hardly be brought fairly in view. The proximity of the stream of blood in the innominate artery on the right side is a great, but not a fatal, objection to this operation. Porter* tied the right carotid successfully within half an inch of the bifurcation of the innominate.

The operation of tying the common carotid artery used to be looked upon as one of the most successful in surgery; and perhaps, if we regard the important parts whose circulation is interfered with, that opinion may seem relatively justified; but absolutely the mortality is now known to be very considerable.

In the paper on the subject by Dr. Norris above referred to, the result of 149 cases in which the carotid was tied, has been tabulated. Of these, 54 died, or more than one-third; an amount of mortality much exceeding that of any of the commoner operations of surgery. Dr. Norris's paper, however, includes all classes of cases, tabulated as:—I. Operations for aneurisms (Hunterian); II. For wounds; III. In or previous to extirpation of tumours; IV. For cerebral affections; V. For erectile tumours of the orbit, scalp, &c.; VI. On Brasdor's method for aneurisms. We may consider separately the cases in which the artery is tied for the cure of a disease, by excluding classes II. and III.; and then Dr. Norris's table (rejecting one case, in which it is doubtful whether the artery was really tied) gives us exactly 100 cases, with a mortality of 33. It seems, therefore, fair to say, that the ordinary ligature of the common carotid for diseases involves a risk which may be represented on an average by a mortality of one-third. Possibly, where the disease is remote, the chance of recovery is greater. In Dr. Morton's paper, above referred to, out of thirty cases where the carotid was tied for aneurism in the orbit, only three died.

Dr. Pilz's statistics † give exactly 600 cases—thus divided:—

	Cases.	Cured.	Died.	Unaccounted for.
For bleeding	228	94	128	6
For aneurism	87	55	31	1
For tumours	142	87	49	6
For extirpations	71	38	25	8
For affections of nervous system	34	33	1	—
For aneurism, on Brasdor's method	38	12	25	1
	600	319	259	22

Deaths 43·16 per cent.

Dr. Pilz deducts from the mortality 29 cases where death was due to other causes, *e.g.* where the carotid has been tied for hæmorrhage really due to wound

* Sup. cit.

† Langenbeck's *Archiv.* vol. ix. 1868, p. 394.

of the vertebral artery, and which proved fatal. The general inference as to the mortality due to the operation is the same as from Norris's paper. The extraordinary success of the operation when performed for 'affections of the nervous system' (*i.e.* for epilepsy, headache, and neuralgia), shows that in this, as in other ligatures of arteries, it is not so much the intrinsic danger of the operation which leads to its great mortality, as its performance upon patients already seriously diseased or injured—though this does not, of course, excuse the performance of the operation in such cases.

M. Le Fort's paper on the therapeutical value of the ligature of the common carotid artery, in the *Gaz. hebdomadaire*, 1868, Nos. 28, 30, 35, does not contain so large a number of cases as those of Dr. Pilz, his total being 435, nor is it accompanied by the references. It is very possible, however, that it may be free from the errors which (as M. Le Fort hints) somewhat detract from the value of the German author's elaborate paper. M. Le Fort's essay is well worthy of perusal; and I cannot forbear to quote its conclusion, as being, I think, justified by our experience of this operation: 'The ligature of the external carotid ought to be substituted for that of the common carotid whenever it is possible; and if the latter operation is a rare one, it ought to be still rarer; not only from its danger, but also because it is inefficacious in many more instances than would be thought, if judged merely by some fortunate cases which are known and quoted by all the world.'

Both carotids have been tied in a great number of cases. In one case only* the double ligature was simultaneous; the patient died in twenty-four hours of coma. The simultaneous ligature should never be performed unless the chance should be afforded of thus treating a case of wound, which, however, is very improbable. But there are many cases of successful ligature of both carotids, with an interval of time between the two operations. Tables of these cases will be found in Dr. Pilz's work above referred to (p. 415), and in Mr. Erichsen's (vol. ii. p. 67). The general result seems to be, that (excluding Mott's fatal case of simultaneous ligature) there have been 26 or 28 cases, of which at least 18 (possibly 20) recovered. Some of the patients who recovered had severe cerebral symptoms, and one lost an eye from disorganising inflammation; but the above list shows clearly the possibility and even probability of recovery from so formidable an operative procedure. But the propriety of undertaking such treatment may well be questioned. In many of the cases the operations were performed for the cure of epilepsy—a proceeding which I believe nobody would now countenance. Nor in aneurism by anastomosis can I believe that there is enough prospect of cure to justify so dangerous a measure. A few of the operations were done for hæmorrhage—and of course any measure which is necessary to check hæmorrhage is justifiable—but we can hardly believe that such cases will often occur. On the whole I think ligature of both carotids can hardly ever be advisable, and very rarely justifiable.

The chief causes of death after ligature of any large artery, excluding those affections which depend on previous disease and the complications which follow on any grave surgical operation, are secondary hæmorrhage and gangrene. The former is comparatively rare after ligature of the carotid, in consequence of

* V. Mott, *Amer. Med. Journal*, July 1847; *Prov. Med. and Surg. Journal* 1848, p. 137.

its long course without branches. Still it is not perhaps so uncommon as is generally supposed, since among the fifty-four fatal cases in Dr. Norris's table, hæmorrhage is noted as the cause of death in fifteen of them, and it may have been present as a symptom in many of those which recovered.

Gangrene shows itself principally in the form of softening of the brain. The external parts of the head and neck are never, as it seems, affected with gangrene; a fact which is readily accounted for by the free anastomoses and liberal supply of the vessels of the face and neck. The anastomoses in the brain are indeed even more abundant; but then the brain appears to be more in want of a constant and equable supply, and to tolerate badly the withdrawal for even a short space of so large a quantity of blood as is brought to it by this great artery. Twelve of the fifty-four cases in Dr. Norris's table seem to have proved fatal from some symptoms referable to the brain, which, however, are very variously stated; 'convulsions,' 'apoplexy,' and 'inflammation' of the brain, being the more common headings. It may be allowed us to doubt, in the absence of more exact information, whether this 'inflammation' was not, in most cases at any rate, atrophic softening.*

Either the external or internal carotid may be tied for a wound of the vessel itself in the carotid triangle. The operation does not essentially differ from that on the common carotid. An incision made in the same line but higher up will lead down directly upon the internal carotid. But the circumstances which would justify ligature of either of the secondary carotid arteries, except for wound, must be very rare. In aneurism affecting the internal carotid in the cranium, I have already stated the reasons which would lead me to prefer the ligature of the common carotid. I have not met with any account of cases of true aneurism of the branches of the external carotid, except traumatic aneurisms of the temporal artery, which are usually under the control of direct and indirect pressure, otherwise the temporal artery itself may be easily tied either by the Hunterian or the old method. But cirroid or anastomotic aneurisms of the branches of the external carotid are not so uncommon, and, upon the failure of other methods, it might be thought advisable to

* See the observations on this head in Dr. Pilz's paper above referred to, p. 408 et seq.

tie the external carotid artery. If so, it would be perhaps better to secure the arteries on both sides at the same operation, as was done successfully by M. Maisonneuve in four cases. In wounds of arteries derived from the common carotid, occurring in inaccessible situations, the common carotid artery itself has usually been tied, and with frequent success. This operation has called down the vehement censure of Mr. Guthrie in cases of wound of the internal carotid from the fauces; but the operation by which he proposed * to secure the two ends of the bleeding internal carotid, after having divided and turned up the ramus of the lower jaw, has not yet been demonstrated to be practicable on the living body, and it seems hardly worth while to describe an operation which will probably never be put in practice.†

We may, however, allow that every exertion should be made to secure the bleeding artery itself in any case, and that it is only where that operation is plainly impossible, that it is justifiable to resort to so uncertain a measure as tying the trunk-vessel.

In order to find the external carotid, M. Guyon, who has written a special memoir on the subject,‡ gives the following directions. Make an incision downwards from a little external to the angle of the jaw to near the anterior edge of the sternomastoid, from one-third to half-an-inch below the upper border of the thyroid cartilage; dissect away some cervical glands and the venous branches, connected chiefly with the facial and lingual veins, which lie over the artery. The glands should not be torn away or lifted, for fear of tearing the veins to which they adhere closely, but freely incised, and the veins tied and divided if necessary. Then look for the hypoglossal nerve, which crosses the artery perpendicularly, and will serve as a guide to the vessel lying immediately beneath. There is usually about half-an-inch of the trunk available for the purpose of placing the ligature, between the origin of the superior thyroid, which is generally close to the bifurcation, and that of the lingual, facial and occipital above. The identity of the vessel may be known by its relation to the hypoglossal nerve, the presence of a collateral (the superior thyroid) when it happens to come into view, and the fact that pressure on the exposed vessel commands the pulse in

* *Commentaries*, p. 256.

† The usual practice of securing the common carotid, is recommended in the essay on INJURIES OF THE VESSELS, vol. i. p. 751.

‡ *Mém. de la Soc. de chir. de Paris*, tome vi. 1863.

the temporal. In twenty-three of the cases mentioned in M. Guyon's paper where this vessel was tied, none died from the operation, and none had secondary hæmorrhage. In four of these both external carotid arteries were tied, so that the number of patients was only nineteen. The twenty-fourth case quoted by M. Guyon, was one in M. Maisonneuve's practice, where secondary hæmorrhage took place after the separation of the ligature: the common and internal carotid were tied, and the sympathetic nerve was injured. The patient died.

Any of the branches of the external carotid which arise in the carotid triangle may require to be tied on account of a wound; but no special directions appear necessary. The diagnosis of the particular vessel injured would be impossible till the parts had been exposed, when the bleeding would be the only sure guide to the mouth of the artery. But the lingual artery may require ligature on account of disease or injury. The operation has now been frequently performed, either to check the growth of cancerous tumours or to arrest hæmorrhage from such tumours, or even from a wound. In either case it might be necessary to secure the artery on both sides.*

The operation is thus performed: The patient being in the recumbent position, with the head drawn over to the sound side, and a small pillow under the neck, an incision is made obliquely downwards and backwards, about two and a half inches in length, its centre being opposite the end of the great cornu of the hyoid bone. The superficial parts being divided, the point above mentioned should be kept in view, and the lingual nerve exposed. The artery runs deeper than the nerve to gain the deep surface of the hyoglossus muscle, and must be carefully searched for in the cellular tissue. This operation is more difficult than the description would seem to imply. The reason is, that as the parts are unsupported except by the loose and soft wall of the pharynx, the vessel is constantly retreating from the operator, who must be careful in conducting his dissection, for fear of wounding the pharynx. As the vessel is tortuous, it is necessary to keep close upon the end of the great cornu of the hyoid bone—the only sure guide to it. In the dissection, a large vein, the internal jugular or one of its branches, may be exposed.

* See Moore, *Med-Chir. Trans.* vol. xlv. p. 56. The most complete memoir on the subject of ligature of the arteries of the tongue with which I am acquainted is by M. Demarquay, *Gaz. méd. de Paris*, 1867, p. 634.

The French method, which M. Demarquay seems to have adopted, is to make an incision more or less horizontal through the fibres of the hyoglossus muscle at the apex of the digastric triangle, below the level of the ninth nerve, and parallel to the hyoid bone. This is believed to be more certain than the other method, since the artery sometimes comes off from the carotid along with the facial, and in such cases passes downwards to gain the cover of the hyoglossus. Mr. Heath informs me that he tied the lingual artery in this manner for hæmorrhage in cancer of the tongue on January 1, 1869, and found no difficulty, though the operation was performed at night. On the division of the muscle, the artery at once presented itself.

In the former edition of this work, the ligature of the smaller arteries of the neck was passed over without special mention, nor indeed is the subject one of any practical importance; but as the superior and inferior thyroid arteries have been tied in bronchocele, though the operation is not one which can be recommended, it may be as well to describe the method by which they may be secured.* For the superior thyroid an incision is to be made two inches long, parallel to the inner margin of the sterno-mastoid, its centre corresponding to the great cornu of the thyroid cartilage. This brings into view the omohyoid muscle and the sheath enclosing the jugular vein, and common carotid; the fibrous lamellæ which cover the artery having been torn apart with a director, the superior thyroid may be found running downwards between the vessels and the thyroid gland; or if the facial is the artery sought for, it can be found by the same incision, the search being conducted upwards towards the jaw, where the artery is found between the great vessels and the submaxillary gland.

The inferior thyroid is to be sought by an incision similar to that for the carotid in the lower part of the neck. It is usually concealed by the upper part of the omohyoid muscle. This muscle must therefore be depressed or divided, and the artery sought for between the trachea or œsophagus and the trunk of the carotid. The recurrent nerve and the descendens noni will be endangered in this operation.

* See Mott's *Velpeau*, vol. ii. p. 227.

REGIONAL SURGERY OF ANEURISMS IN THE
ABDOMEN AND LOWER EXTREMITY.

THE FOOT AND LEG.

As in the upper extremity, so still more in the lower, aneurism hardly ever affects the arteries below the great hinge-joint, except as the result of accident. Spontaneous aneurism, it is true, is not unknown in the leg; but it is extremely rare. The museum of St. George's Hospital contains a specimen of aneurism of the posterior tibial artery cured by ligature of the femoral; and other scattered examples of these aneurisms may be found in pathological collections. These aneurisms, like those in the fore-arm, will hardly ever be found originating spontaneously except in subjects affected with extensive disease of the heart and arteries; and appropriate position, bandaging, and digital pressure on the first accessible artery above the tumour, will be the appropriate means of cure for these, as for those. If this treatment should fail, it will be for the surgeon to consider whether his patient has sufficient vital power to survive the ligature of the femoral artery, and whether the disease is grave enough to justify the risks by which that operation must be attended.

Pressure and proper position will, in all probability, stop bleeding from any vessel in the foot; but it is possible that a traumatic aneurism in the foot or near the ankle may necessitate the ligature of one or other of the tibial arteries; these vessels, however, are much more often tied on account of wound.

The *ligature of the anterior tibial* may be thus performed. If the vessel requires to be tied above the middle of the leg, it will be found very deeply placed on the interosseous membrane, between the thick muscular bellies of the tibialis anticus on the one side, and on the other of the external longus digitorum above, and extensor proprius pollicis below, tightly bound down by the fascia of the leg. In order to reach it on the living subject with any tolerable facility and in any tolerable time, the intermuscular space must be hit, and the vessels exposed without any groping about among the muscles. This can be easily done on the dead subject, but on the living the operation must be one

of considerable difficulty. An incision, proportioned to the fatness of the leg (about four inches might be taken as a moderate length), is to be made in the line joining the head of the fibula with the middle point between the two malleoli. The skin and superficial fascia being separated from the deep fascia, a whiter line running down the latter will be seen marking the inter-muscular space.* This is to be slit up to the same extent as the original wound, and the muscles drawn forcibly apart with broad retractors, the ankle being flexed in order to relax them. Then, at the bottom of the deep interval, the nerve will come into view, and below it the vessels will be found inclining to its inner side. Even in the dead subject there is often considerable difficulty in getting a ligature round the anterior tibial (especially if the operator wishes not to include the veins, which, however, in the living body would be almost a matter of indifference); and this difficulty would be much increased in practice by the fact that the operation would probably be undertaken on account of a wound, and that the neighbouring parts would be obscured by the extravasated blood, the muscles perhaps lacerated, and the cavity in which the vessel lies so deep that the bleeding, by which alone the artery could be recognised, would also constantly obscure and hide the bleeding orifice. Hence in such cases great pains should be taken to endeavour to restrain the bleeding by graduated compresses, or by digital pressure in the wound, before resorting to an operation which may fail, and if it does so, may cost the patient his limb.†

In the lower part of the leg, where the muscles have ended in their tendons, and where the vessels are supported on the tibia, there will be much less difficulty in finding the artery; but the line of incision is the same, and the same muscle (tibialis anticus) serves as a guide, the artery lying on its outer side.

The remarks above made, as to the propriety of endeavouring, if possible, to avoid operating on small arteries so deeply seated as those of the upper part of the leg, apply to the posterior tibial, and still more forcibly to the peroneal, which, however, has been successfully tied on account of wound by Mr. Guthrie;‡

* Guthrie recommends that the foot be alternately flexed and extended to bring these muscles into view more distinctly.

† I am informed by Mr. Moore, that in a case where he had occasion to tie the anterior tibial for a wound, he found much assistance to discovering the position of the vessel from tracing back its branches, which are given off in considerable numbers to the muscles around it.

‡ *On Wounds and Injuries of Arteries*, p. 35. 1846.

but no special instructions are needed for this operation, which consisted merely of making a very long incision in the middle line of the calf (seven inches in length, with its centre at the wound), dissecting down towards the fibula, turning out the clots, and looking for the bleeding point; in doing which it was necessary to cross the incision by one running towards the fibula, so as to turn down two little flaps. The bleeding point having been seen, a sharp hook was struck into the tissues below it, and the whole was tied up in two ligatures above and below the part whence the bleeding proceeded. As the patient recovered, it was, of course, impossible to affirm that the peroneal was really the artery which had been tied.

Ligature of the posterior tibial in the upper part of its course, where it lies under the deep fascia which separates the mass of muscles forming the superficial layer of the calf from those which form the deeper layer, can be effected in one of two ways. The first of these consists in making an incision of suitable length (say six inches) along the posterior edge of the tibia, and having divided the fascia, pulling the gastrocnemius away, cutting the soleus off the tibia to the extent to which it is exposed, and thus coming down upon the deep fascia, which covers the artery, and which is to be divided with the usual precautions, in order to search for the vessel lying below it. This way of making the incision, which is the old method of reaching the vessel, is condemned by Mr. Guthrie as ‘difficult, tedious, bloody, and dangerous;’ and he proposes to substitute for it a vertical incision along the middle line of the calf, over the position of the vessel, through the gastrocnemius and soleus muscles. Mr. Guthrie himself never had the opportunity of carrying out this suggestion; but it was put in practice by Mr. Arnott in a case where he tied the artery for a wound.*

In that case, indeed, the position and direction of the external wound would have indicated some such course; but Mr. Arnott has put on record his preference for Mr. Guthrie’s method, and advises that it should be followed if it should ever become necessary to tie the posterior tibial on account of aneurism situated low in the leg; a necessity which does not seem hitherto to have occurred. Mr. Arnott, however, remarks about his operation what is probably even more applicable to the old procedure. ‘It is not one which should be undertaken incon-

siderately. It requires good light, and intelligent assistants. The case which has been described occurred in the daytime; and from what was then experienced, I am disposed to think that it would not have been successfully performed by artificial light, or at least with greatly increased difficulty.* The difficulties which Mr. Arnott experienced were dependent, he says, on the depth of the wound, the pain and cramp on pressure of the divided muscles, and the venous hæmorrhage from concomitant wound of the *venæ comites*. Of these difficulties, Mr. Arnott rates the first as the least, and the last the greatest. The second would, of course, in the present day be avoided entirely by anæsthesia; but the third must always be anticipated in operations for wound of the artery, since the *venæ comites* are closely connected to it. Pressure in the angle of the wound from which the bleeding comes must be maintained as much as possible during the operation by the finger of an assistant. The trunk of the femoral or popliteal is of course secured by a tourniquet. An incision is to be made six or seven inches in length, down the middle of the calf of the leg, including the skin-wound in its centre. The gastrocnemius and soleus muscles are to be freely divided in the course of the wound, and held aside by broad retractors. Now the operator should search carefully for the deep or intermuscular fascia, immediately beneath which the posterior tibial vessels will be found. The situation from which the bleeding comes will point out whether it is the tibial or peroneal. If the latter be the artery wounded, most likely a good part of the flexor longus pollicis must be scraped off the fibula in order to find it, or (as Mr. Guthrie seems to have done) all the tissues around the bleeding point must be included in the ligature. If it be the tibial, it may be exposed with rather less difficulty; still, it is a most difficult operation, as will be evident to any reader of Mr. Arnott's account, although in that case the wound was only recently inflicted, and Mr. Arnott had able assistance at hand. In cases where much blood has been infiltrated into the leg, obscuring all the neighbouring parts, or where the surgeon is not very much versed in operations, or has to trust mainly to his own hands, it would perhaps be the better course to amputate; but I may be excused for repeating that properly-applied and carefully-graduated compresses, or the prolonged pressure of a finger in the wound, enlarged if necessary, would often render

* Op. cit. p. 51.

either operation unnecessary. In a recent traumatic aneurism, probably one of the various methods of applying direct or indirect pressure would succeed. If any operation became necessary, most surgeons would prefer to tie the femoral artery. Some, perhaps (but they would be very few), might treat the case, like a wounded vessel, by the old operation.

If the posterior tibial artery requires a ligature in the lower part of the leg, the operation is more simple, on account of the less depth at which it lies. An incision is to be made, about three inches in length, parallel to the inner border of the tendo Achillis, and the vessel is to be sought on the outer side of the two large tendons which pass behind the inner malleolus, that of the flexor longus digitorum being the nearest to the vessels. Behind the ankle the tendon of the flexor longus pollicis is on the opposite (external) side of the artery, but in ordinary cases will not come into view.

The popliteal artery has also been tied on account of subcutaneous rupture, unsuccessfully as far as the result of the case went, since gangrene set in on the third day, followed by amputation and death; but no difficulty was experienced in the operation,* which is thus described by the operator: † 'Mr. Poland made an incision from seven to eight inches in length along the course of the popliteal artery, and cleared out much coagulum, and without difficulty found the ends of the ruptured artery lying an inch and a half apart; the upper end seemed to be plugged by coagulum, and was secured by ligature; the lower end seemed to be patent, and was similarly ligatured. The popliteal vein was distinctly seen, and appeared to be uninjured.' †

In the *Lancet* for August 28, 1869, will be found an interesting case in which Mr. J. D. Hill tied this artery to check the growth of an encephaloid cancer of the leg. The patient survived nearly four months, but died of hæmorrhage from the diseased tissue. The operation seems to have been unattended with difficulty, and being performed on parts free from extravasation or swelling, was accomplished with a shorter incision than in Mr. Poland's case. Mr. Hill gives

* In the only two other cases, however, reported in Mr. Poland's paper, where the artery was sought for, the operation proved impracticable. The femoral artery has also been tied on account of this injury in two cases, but gangrene and death followed in both. Mr. Poland speaks in terms of merited reprobation of the practice.

† *Guy's Hospital Reports*, 3rd series, vol. vi.

† On examining the parts after the amputation, Mr. Poland found that the knee-joint had been laid open by an extensive laceration of the posterior ligament, a complication which would probably have precluded recovery even had gangrene been averted; and as this same complication was present in three cases successively admitted into Guy's Hospital (the first three in Mr. Poland's collection), the point ought to be carefully investigated during the operation of tying the artery for rupture, by passing the finger into the deep parts of the wound, when if either condyle of the femur can be felt bare, amputation should be performed.

a diagram of the anastomotic circulation, which is described as being carried on 'by the anastomotica and superior internal articular arteries communicating directly with the anterior tibial recurrent, and by the descending branch of the external circumflex artery receiving the superior external articular, and inosculating with a branch of the anterior tibial recurrent. The posterior tibial artery was supplied by the inosculation of some muscular twigs arising from either [tibial] artery, and passing across just opposite the anterior tibial recurrent. The posterior tibial was small and contracted.'

POPLITEAL ANEURISM.

Although popliteal aneurism is so frequently curable without operation, yet operations for its cure constitute the great majority of those performed for aneurism.* The popliteal artery is so frequently diseased, because it is liable to strains both in flexion and (though to a much less degree) in forced extension of the joint;† also because it is the end of a large tube, convex alternately forwards and backwards, which divides abruptly into much smaller branches, and is supported only by fat, while its branches plunge at once among muscles.

The symptoms of popliteal aneurism are usually quite characteristic.‡ The attention of the patient is called to the part by the tumour or by pain and stiffness of the limb, or by the pulsation—very commonly the latter; and on examining the part the surgeon is left in no doubt of the nature of the complaint. The aneurismal bruit is usually distinct, though cases are sometimes met with in which it is absent. The feeling of the pulsation differs somewhat according as the aneurism is growing towards or away from the joint; that is, according as it is situated on the front or the back of the vessel. The more usual position appears to be at the back of the artery towards the skin of the ham; and then the pulsation is of the usual equable heaving and expansive character. But when the aneurism is growing towards the joint, and the artery therefore is raised upon its posterior surface towards the skin, the pulsation feels much more thrilling, and a distinct line of separate pulsation often marks the course of the vessel. The position of the aneurism also materially influences the probability of

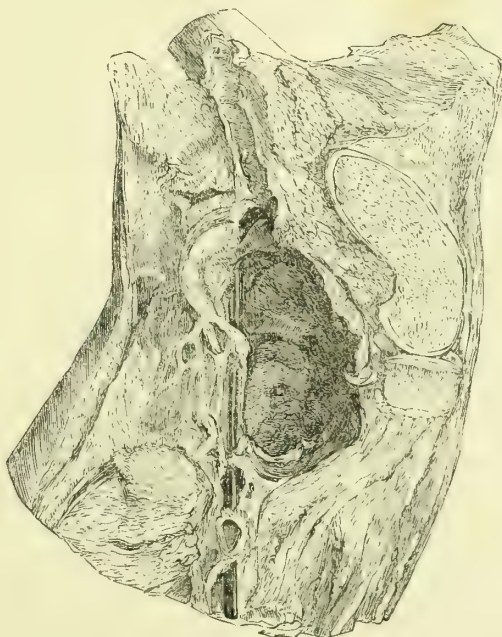
* In the *Med. Times and Gaz.* (supr. cit.) seventy-five cases of ligature of large arteries are reported, of which fifty-one were of the femoral, in almost all cases for popliteal aneurism.

† Very few sedentary persons or females suffer from this disease. In Norris's table, out of 155 patients, five only were females.

‡ Further observations on the diagnosis of bursal and other tumours in the ham from aneurism will be found in the essay on DIAGNOSIS AND REGIONAL SURGERY.

complications involving the joint. A large tumour rapidly growing on to the posterior ligament of the knee, must cause considerable irritation in the joint; and synovial inflammation from this cause is a frequent accompaniment of popliteal aneurism. Still further, the resistance to the growth of the sac afforded by such firm structures as the bones and ligaments of the joint soon leads to ulceration, so that such aneurisms are liable to burst into the knee-joint; the symptoms and indications of which event have been pointed out on pp. 427, 483.

FIG. 167.



Section of a popliteal aneurism. The section runs perpendicularly through the artery above; a probe marks the course of the lower part of the vessel. (Museum Royal College of Surgeons, No. 1702.)

The part of the artery affected varies; but the aneurism usually presents in the middle of the popliteal space, and bulges out below either hamstring. On dissection, the opening in the artery is most commonly found near its lower end.

The ordinary relations of popliteal aneurism are well shown in a preparation by John Hunter in the Museum of the Royal College of Surgeons, of which the annexed figure is a copy.

Treatment.—The treatment of popliteal aneurism is usually successful, since such tumours partake of the nature of the

paratively healthy persons. Besides, there is a long tract of artery above the tumour in the most favourable position for compression, and the anastomotic branches come off in tolerable profusion just above the tumour, and enlarge readily.

Before other severer measures are tried, genuflexion ought undoubtedly to be attempted. If bending the knee to its full extent stops the pulsation in the tumour, the best hopes may be entertained of its success. The kind of aneurism most adapted for it appears to be that which is situated on the back of the artery, and has not yet got very near the skin. In a tumour which appears on the point of bursting, it would be imprudent to insist on its trial; nor would it be likely to succeed if the pulsation were unaffected, or even (which seems theoretically possible) increased. Pressure, instrumental or digital, on the femoral artery may succeed when flexion fails, or a combination of the two may appear more efficacious, and is easily arranged. In applying pressure, it is important to remember that the artery changes its relation to the bone in its course down the thigh, and that in order to command the circulation with the least possible force, the pad ought to be directed towards the femur. The method of applying pressure in this situation has been discussed above.

If under the use of pressure the tumour is making visible progress, the femoral artery must be tied;* and this becomes still more necessary if the sac have burst; since, if the operation be delayed, the occurrence of gangrene will probably necessitate amputation.

Amputation also becomes necessary on the failure of the ligature, except in some rare cases of recurrent aneurism, when the femoral can be tied in Hunter's canal (see *supr.* pp. 480, 481).

Ligature of the femoral artery.—The femoral artery may be tied at three parts of its course: (1) above the origin of the profunda; (2) at the apex or lowest point of Scarpa's triangle; (3) in the canal formed by the tendinous fibres which connect the adductor magnus with the vastus internus. Of these, the last proceeding, that originated by Hunter, is now disused, unless for exceptional cases of recurring aneurism, such as Sir A. Cooper's, above quoted; and the second is the one generally employed in popliteal aneurism; the first being reserved by

* A case cured by acupressure is referred to on p. 435.

most surgeons for certain cases of aneurism in the thigh, and as a preliminary to some operations.

The great advantage of Scarpa's operation, for securing the artery just as it is being crossed by the sartorius muscle, is that the vessel is exposed at a point where it is superficial, and therefore easily found; while at the same time it is far from the origin of any large branch. The operation in a natural condition of parts and a patient not very stout is usually easy. If the outline of the sartorius muscle is plainly perceptible, this will perhaps be the easiest and surest guide. Otherwise a line drawn from the centre of the fold of the groin to touch the inner border of the patella when the foot is a little abducted, will mark the course of the vessel. An incision three or four inches long having been made in this direction through the skin and subcutaneous tissue (in which it will be well to avoid any large branch of the saphena vein), the fascia lata will be recognised, and should be divided on a director to the whole extent of the wound. This should expose the inner edge of the sartorius, which must otherwise be sought for by dividing the cellular tissue carefully without going deeper into the wound; and when the muscle is recognised, but not before, the sheath of the vessel is to be sought. It is generally found at once, by drawing the muscle slightly outwards, and the pulsation is felt. A nerve is usually seen in front of the artery, and must be excluded from the ligature. This may be either the internal saphenous nerve or a smaller branch of the anterior crural.* A small opening is to be made in the sheath, and enlarged to such an extent that the artery is fairly exposed; and then the vessel should be so far cleaned as to allow the aneurism-needle to be passed round it without material resistance. The great danger at this step of the operation is lest the vein should be injured, or should be included in the ligature. To avoid the first mistake, great gentleness is required in cleaning the artery and in passing the needle round it; while the second seems impossible if the vessel have been

* A small nerve is often seen on the front of the sheath, but the saphenous nerve itself does not come into connection with the artery so high up as the usual seat of operation. Where it is in relation with the sheath, it lies rather external to the position of the artery, firmly bound down by a separate layer of fascia, which appears to form a portion of the sheath. Hence, if the sheath is opened only by a small puncture over the inner part of the vessel, the nerve will not come into sight.

once fairly and cleanly exposed. The position of the vein must be accurately remembered; it lies almost directly behind the artery, inclining perhaps a little to its inner side. Hence we are usually recommended to pass the needle from within outwards. This being so, if the front of the artery have been once cleanly denuded, and the point of the needle have been fairly applied to it, it seems impossible that the needle can be thrust to the deeper side of the vein, without an amount of violence which is never used on the living subject; nor can the needle even perforate the septum which separates the artery from the vein, so as to wound the latter, without more force than is justifiable. If the occurrence of venous hæmorrhage shows that the vein has been punctured,* the bleeding ought to be commanded by pressure, which is not difficult, and the operator must make up his mind either to abandon the operation for the time, and seek the vessel at a higher part of its course after a few days, or (which is perhaps the preferable course) to enlarge the incision upwards, and tie the artery with more care, about an inch above the spot originally selected. The ligature should on no account be tightened in the part where the needle has first wounded the vein, since in this way the thread would be left in the vein to act as a seton, and phlebitis could hardly fail to ensue, and would most likely prove fatal. If the needle have glided round the vessel without any such accident, the next step is to determine that the tissue embraced by it is really the artery, and nothing else. This is easily ascertained by pressing lightly on the tissues raised by the needle, and examining the part with the finger. The pulsation of the vessel will be felt; on making pressure, the beating of the aneurism will cease at once; while, if any doubt exists on that point, the absence of congestion shows that the vein is not included. Nothing then remains to be done except to tie the ligature firmly, and close the external wound with strapping or sutures.

In a case of ligature of the femoral artery which is to do well, the warmth of the foot, which is maintained by wrapping the limb in cotton wool, remains slightly above that of its fellow for a few days; the patient lying quiet does not notice

* Slight arterial hæmorrhage is sometimes observed as the needle is passed round the artery, and stops when the ligature is tightened. It proceeds, in all probability, from the wound of a minute branch near its origin from the vessel.

the numbness and partial paralysis which would no doubt manifest themselves if he tried to move about; sensation is perfect; the ligature may be expected to fall any day after the first week.*

The chief danger after the operation is from gangrene. In Dr. Norris's statistics, † of 204 operations (for all causes), fifty died. Out of these fifty, the cause of death is not stated in four; and of the remaining forty-six, twenty-three, exactly one-half, died from gangrene, while hæmorrhage proved fatal in eight cases only; five of the remaining deaths are attributed to phlebitis, one to sloughing of the sac, and the rest to accidental causes common to all operations—tetanus, fever, hectic, pyæmia, &c.

Hæmorrhage, however, occurred in numerous cases in which it did not prove fatal, having been arrested by pressure. In order to apply pressure effectually to the femoral artery when secondary hæmorrhage takes place, a graduated compress should be fixed very carefully on the wound by means of a *presse-artère*, or the bleeding point should be commanded by the fingers of a relay of well-instructed assistants. Should these means fail to arrest the bleeding, the external iliac artery must be tied, or the limb amputated, unless the surgeon choose to cut into the wound, and tie up again the bleeding portion of the vessel. Mr. Erichsen declares himself in favour of the latter mode of treatment. The first is the course most usually prescribed in our surgical works; but it has always (according to Mr. Erichsen) been followed by gangrene. The ligature of the bleeding portion of the artery is an operation which must always be difficult, and which may prove impracticable; yet it should be attempted when the parts are not extremely swollen, and other circumstances are favourable.

In a case where Mr. Pollock had tied the femoral artery, at St. George's Hospital, secondary hæmorrhage came on, apparently from the upper end of the tied artery, on the eleventh day—the ligature not having separated, though it was quite loose. In the absence of Mr. Pollock from London, I was sent for, and on consultation with my colleagues, determined to attempt to secure the vessel, and

* The earliest period at which the separation of the ligature has been noted in a successful case, free from hæmorrhage, appears to be the eighth day; but it rarely comes away before the eleventh. In one case it came away on the sixth day, but hæmorrhage occurred. In 91 cases out of 137 it separated before the twentieth day; but it has been known to remain on the vessel up to the sixtieth day.

† *Am. Journ. Med. Sc.* Oct. 1849, n. s. vol. xviii. p. 313.

should this prove impracticable, to amputate. I succeeded without much difficulty in tying again the upper end of the artery, which was perfectly open, and the operation was so far successful; as hæmorrhage did not recur during the eight days which the patient survived. The cause of his death was phlebitis leading to pyæmia.

Renewed ligature of a tied artery is, however, a formidable and uncertain operation, which should only be undertaken as an exploratory proceeding, preliminary to amputation, if this should be found necessary. In all cases of severe secondary hæmorrhage, there seems little doubt that amputation is the safest measure for the patient, though it is one to which no surgeon would willingly resort.

A slight amount of gangrene is not always inconsistent with the preservation of the limb; while of the cases of more extensive gangrene, many are saved by secondary amputation. Six cases of successful amputation are recorded in Norris's table.

Porta's statistics give somewhere about the same mortality* as those of Norris. It may be said, however, that these statistics give an unfair view of the mortality, since many of the operations were performed by the older surgeons on exploded and unscientific principles; or that successful operations on the femoral artery are so common that they are not considered worth publication. But no such objections can lie against the statistics collected by Mr. Hutchinson † of the cases of ligature of this artery in metropolitan hospitals. Out of fifty cases, sixteen have died, or, in round numbers, one-third. Mr. Bryant's tables of amputation of the thigh at Guy's Hospital for all causes, ‡ with which those collected by the present writer from St. George's Hospital § agree in all essential particulars, give a mortality considerably under one-third. So that ligature of the femoral artery seems to have proved more fatal than amputation of the thigh in the practice of London surgeons

* It would be wrong to quit the subject of the mortality after ligature of the femoral artery, without noticing the fact that Mr. Syme tied the artery twenty-three times in succession without any unfavourable symptom (*Principles of Surgery*, 1856, p. 99). Still, in urging this remarkable fact as an argument against the use of pressure, I cannot help thinking that that distinguished surgeon has been misled by a success which must be exceptional in the practice of any operator, however skilful.

† *Med. Times and Gaz.* vol. ii. 1856, p. 515; i. 1860, pp. 12, 35, 62, 89, 117.

‡ *Med.-Chir. Trans.* xlii. 70.

§ *Med. Times and Gaz.* vol. i. 1861, p. 358. See also *St. George's Hospital Reports*, vol. i. pp. 303, 4, where the mortality of amputations of the thigh for all causes is exactly one-third.

during the last few years, taking all cases of each operation indiscriminately.

If it be necessary to tie the artery in Hunter's canal, which, however, can only be the case either for wound or after the failure of the common operation, the same line of incision will be made, but lower down; and it will be necessary to divide the muscles freely. Hence the operation is more protracted and bloody, but no important parts are endangered in either. The principal risk is of wounding the vein, or of including it or the saphenous nerve in the ligature.

FEMORAL ANEURISM.

Spontaneous femoral aneurism is regarded, with reason, as a more serious affection than popliteal, since the latter often affects persons whose vascular system is in all other respects sound, while the former gives much reason to suspect a generally atheromatous condition of the vessels, in which case the existence of organic disease of the heart, or of internal aneurism, is exceedingly probable. Every such case, therefore, should be carefully examined with reference to these points before the treatment is fixed. The diagnosis of an aneurism in the thigh can hardly be attended with difficulty. Some doubt might exist as to the vessel upon which it was seated, whether the superficial or deep femoral; but the doubt would not have much effect upon treatment. In traumatic cases, the diagnosis between simple and arterio-venous aneurism should be attended to; but enough has been already said upon that point; what follows will refer entirely to the treatment of common aneurism in the thigh. Rest, without any special treatment, has been known to lead to the spontaneous cure of a femoral aneurism;* but it would not be good practice to delay the commencement of more active treatment beyond the day or two which is usually allowed in order to familiarise the patient's mind and body with his novel circumstances, unless the tumour were visibly decreasing in size. In all cases in which the sac has not burst, compression of the femoral in the groin ought to be tried, and will usually succeed, especially if there is opportunity for the careful application of digital compression. Nor if the sac has burst is the case by any means desperate. A careful examina-

* Luke, in *Med. Gaz.* May 9, 1845.

tion will show whether pressure with the finger controls the further progress of the extravasation; if it does, compression of the femoral may be tried for a day or two, the case being, however, very carefully watched. On the failure of pressure, recourse is to be had to the Hunterian operation,* which can generally be effected below the groin, in the first part of the artery; but in cases where the tumour extends higher up, the ligature must be placed on the external iliac. The former operation will be described here, the other being appended to the section on Inguinal Aneurism.

Ligature of the common femoral artery is an operation which is not generally regarded with much favour, and which is, therefore, little practised for the cure of aneurism, inasmuch as the operator generally prefers to tie the external iliac. The reason of the supposed danger of the ligature of the artery in this situation is, the proximity of the ligature to large branches. The epigastric and circumflex iliac on the one side, must come off near the ligature if it is placed close to the fold of the groin; and the profunda on the other, if it is placed lower down. The neighbourhood of these large branches would certainly appear likely *à priori* to lead to secondary hæmorrhage; but some doubt is thrown upon this theoretical conclusion by the experience of the elder and younger Porter, the latter of whom reports three cases fully, and alludes to two others, in which the operation was performed by himself and his father, all of which were successful.† Dr. Macnamara of Dublin, in a paper published in the *British Medical Journal*, October 5, 1867, refers to eight cases; all but two being successful. In one of the unsuccessful cases (Mr. Butcher's) the patient died from hæmorrhage, which had occurred previous to the operation; in the other (Mr. Collis's) there was a high division of the femoral; the ligature had really been placed below the bifurcation (*i.e.* it was not a case of ligature of the common femoral at all): the patient died of secondary hæmorrhage.‡ To these cases must be added one under Dr. Gregson's care,§ in which the artery was much diseased. Secondary hæmor-

* This is the ordinary rule; but in cases where there is not much ecchymosis, and in some in which the diagnosis is obscure, the old operation may be performed successfully (see the cases referred to on pp. 457, 458).

† *Dublin Quarterly Journ. of Med. Sc.* Nov. 1860.

‡ *New Syd. Soc. Biennial Retrospect*, 1867-8, p. 298.

§ *Med. Press and Circular*, Sept. 2, 1868.

rhage took place; the external iliac artery was tied, but this did not control the bleeding; gangrene ensued, and the patient died.* But this operation has not as yet been performed sufficiently often to allow of our pronouncing a confident judgment; and it must be left to the discretion of the operator to select the proceeding which he may think best calculated to save his patient's life. The ligature of the common femoral is certainly a far more easy and a less formidable operation primarily than that of the iliac. The artery can usually be felt pulsating; and nothing is necessary except to divide the soft parts over it carefully with a moderate incision, so as to apply the ligature (which should be carried from within outwards) without any exposure of the vein or other parts. The incision may be either longitudinal or transverse, and surgeons who have performed the operation differ as to the relative advantages of the two incisions. The crural branch of the genito-crural or a small branch of the anterior crural nerve may be found running down in front of the vessel, but can be easily avoided.

Another objection to which the ligature of the common femoral is exposed is the liability to gangrene, in consequence of the vessel being blocked up above the origin of both of the great nutrient arteries of the limb. The superficial femoral, which nourishes the lower part of the limb, is comparatively easily reinforced after the ligature by its free anastomosis with the profunda artery; but when both these channels are blocked up, the consequent strain upon the collateral circulation is much increased; and, for my own part, I must express my decided preference for the ordinary operation whenever there is a choice between the two. Yet, if the aneurism were seated in the thigh and the ordinary operation were impracticable, I should prefer the ligature of the common femoral to that of the external iliac.†

* Mr. Erichsen asserts (*op. cit.* vol. ii. p. 110), that out of twelve cases in which the femoral has been tied, only three have succeeded, the others having failed in consequence of secondary hæmorrhage; and thinks that the operation should be banished from surgical practice. But Mr. Erichsen has obviously overlooked the recorded experience of the Irish surgeons.

† In the year 1868 a patient was under my care in St. George's Hospital, in whom Mr. Smyly of Dublin had tied the common femoral artery for the cure of popliteal aneurism in the groin. The operation had been perfectly successful as far as the cure of the aneurism went; in fact, the latter was no longer perceptible. But the patient had lost the second and third toes from

In Norris's table, above referred to, the femoral artery was tied twenty-seven times for aneurism in the thigh, with only five deaths; a smaller proportion than that of ligature of the femoral from all causes. Unfortunately, it is not told us in how many of these cases the artery was exposed above the origin of the profunda; which must, I presume, have been the case in some if not in most of them. The omission in so careful a compilation is doubtless due to the inadequacy of the original notes. In Porta's table, eight are said to have died out of sixteen; but no details are given.

INGUINAL ANEURISM.

Pulsating tumours are always to be viewed with some suspicion when they lie in close proximity to any bone possessing a copious diploe. Hence such affections about any part of the pelvis should always be very carefully examined before they are pronounced aneurismal. The records of surgery abound in instances of tumours in the gluteal and abdominal regions having been pronounced to be aneurism of the large arteries of those parts, when they were really pulsating cancers of the bone; and many of the cases reported by the older surgeons were obviously of this nature, though the mistake was never discovered, and they stand amongst the list of aneurisms. Such a mistake is less likely to occur in the groin, than about other parts of the pelvis; but the surgeon should be on his guard here also. A comparison of the pulse in the chief arteries of the two limbs will be of great service, since it is usually altered in aneurism and not in the pulsatile tumour; and the other points of the diagnosis between aneurism and pulsatile tumour should be carefully examined. (See p. 454.)

The diagnosis having been made, the question will occur whether the case is a fit one for compression, or whether the Hunterian operation must be performed. Compression on the external iliac, in persons not very fat, can be easily applied by the finger; and numerous instances of the success of digital

gangrene, as well as some of the skin at the inner side of the foot; and the cicatrix had ever since been so unsound that it broke down into a torpid ulcer on any slight cause. This had been a source of constant misery and loss of activity to him ever since the operation. I should, however, add that there had been some ulceration of this foot and leg before the femoral was tied.

pressure in this region are recorded. In the face of such facts, no surgeon would be doing his duty who exposed his patient to the great risks of an operation on the external iliac artery, without a well-considered and persevering attempt to cure the disease by pressure, whether digital or instrumental. In these aneurisms complete pressure, both proximal and distal, by means of a tourniquet applied to the artery above and another below the tumour, has been found extremely successful. The patient should be confined to bed for a few days, while the instruments are being got ready—for it is necessary to see that the compressors fit very accurately—and during this interval the way may be prepared by the application of digital pressure for the more serious endeavour to cure the disease. Then chloroform should be administered, and the patient should be kept under its influence for the necessary length of time, whilst all circulation is suspended in the sac by pressure on the external or if necessary the common iliac above and on the femoral below.

An instance of cure of inguinal aneurism by this means is recorded by Dr. Mapother,* in which the pressure was applied on the first occasion for seven, and on the second for twelve hours; and instances of cure by long-continued compression between the heart and the aneurism only by Mr. Eck,† Mr. Lawson,‡ Mr. Hilton,§ and others. In the last named case, there was also popliteal aneurism, which was simultaneously cured. I am informed, however, that in this last case the cure was not permanent in the popliteal aneurism, and the limb was afterwards amputated in the country.

It is possible, also, that direct pressure upon the tumour may assist in the cure, as it seems to have done in Mr. Luke's case, above referred to; but this should be used very cautiously, if at all, since sloughing of the coverings of the tumour would most seriously complicate the case.

Ligature of the external iliac artery.—The operation for securing the external iliac artery is usually regarded as a very successful one; and relatively to the other operations on large trunk vessels, it may be so considered; but the mortality is still very great. Of 153 published cases taken indiscriminately, forty-seven died; a mortality exceeding that of amputation of the thigh.

The operation is performed by making a sufficient incision through the parietes of the lower part of the abdomen, the precise direction of which is not a matter of very great conse-

* *Dublin Med. Press*, March 29, 1865.

† *S. Barth. Hospl. Reports*, ii. 190

‡ *Lancet*, October 26, 1867.

§ *Med.-Chir. Trans.* vol. lii. p. 309.

quence, but which is usually drawn from a little above the centre of Poupart's ligament outwards (so as to avoid the direction of the epigastric artery) to a little internal to the anterior superior spine, from which point it may be curved inwards, as far as may be thought necessary, towards the umbilicus; or it may lie directly over the course of the artery. The muscles are to be divided to the same extent, care being taken in dividing the lowest strata, until the transversalis fascia is reached. This structure can generally be recognised immediately beneath the muscles, and should be divided in the iliac fossa, not far from the anterior superior spine, upon a director, after a hole has been cautiously made in it. The operator will now find a cellular interval lying above the peritonæum; and that membrane, with the intestines, should be gently and gradually pushed over towards the middle line, until the vessels are seen or felt. The vein, it should be remembered, lies internal to the artery; and the genito-crural nerve, or lower down its genital branch, lies on the anterior surface of the vessel. The ligature, must, therefore, be passed from within outwards; and if the nerve have been included in it, care should be taken to slip the thread away from under it before the knot is tied. The ligature of this little nerve need not, however, lead to any bad results. The accident which usually happens in this operation is, naturally, the laceration of the peritonæum. It is not necessarily attended with fatal or even serious consequences; in fact, a successful case was lately published in which the peritonæum had been divided by mistake for the transversalis fascia, to the extent of the external wound; but any injury to the peritonæum should nevertheless be most carefully avoided.

In principle, the various operations described on the iliac arteries reduce themselves to two methods, in one of which the artery is reached from below, while in the other it is approached from without or from above, as has been just described. The latter method is easier when the aneurism encroaches upon Poupart's ligament; the former when the tumour is situated lower down, and the whole of the artery may, therefore, be expected to be found healthy. There is little difference between the two plans, except that the operation from below requires a smaller incision, and is less difficult in appropriate cases; but if the artery be pressed back into the pelvis by a tumour extending up into the groin, it becomes much more difficult, if not impracticable, from adhesion between the tumour and the peritonæum. Sir A. Cooper, in describing the operation from below, advises that 'the centre of the internal oblique and transversalis muscles should be raised from Poupart's ligament. The opening by which the spermatic cord quits the abdomen is thus exposed, and the finger passed through this space is directly applied upon the iliac artery.' The rest of the operation then consists

chiefly in scratching the fascia off the artery, separating the latter from the vein, and passing the ligature round it, which Sir A. Cooper directs to be done from without. Mr. Guthrie, however, justly observes, that the vein is less likely to be injured if the point of the needle be first insinuated between it and the artery, and the ligature carried from within outwards.*

The points to be chiefly guarded against in the ligature of the external iliac artery are, wound of the epigastric artery, of the vas deferens, or other constituents of the spermatic cord, laceration of the peritonæum, puncture of the external iliac vein or of the circumflex vein, ligature of the genito-crural nerve, and a too free disturbance of the subperitoneal cellular tissue. The wound of the epigastric artery is only probable when the operation is practised from below. The vessel can, it is true, be secured, but the bleeding and loss of time are objectionable; and after it is tied, an important anastomosis is stopped up, and the chance of gangrene increased. The vas deferens also is only endangered in tracing the artery upwards. A knowledge of its position, and its peculiar cord-like feeling, will suffice to make the operator avoid it. The laceration of the peritonæum cannot always be avoided. Great gentleness should be used; and before the operation the patient should have been well purged, in order to obviate any distension of the intestines. The clean exposure of the artery is the best safeguard against wounding the vein or including the nerve. The circumflex iliac vein which crosses the end of the artery must be avoided in the operation from below. A careful selection of the method most appropriate to the case before him will enable the operator to reach the artery with the least possible disturbance of the deep cellular tissue. It is true that it may become absolutely necessary to disturb a large extent of the peritonæum from its cellular connections; but this should always be avoided as far as possible, since it greatly increases the risk of diffuse inflammation on one or the other side of the serous membrane.

In Norris's and Cutter's tables† of 153 cases of ligature of this artery for all causes, forty-seven died; out of these the cause of death is not stated in one, was doubtful in one, and in two was unconnected with the operation; of the remaining forty-three, seventeen died of gangrene, and three of sloughing

* Guthrie's *Commentaries*, p. 268.

† *Am. Journ. Med. Sc.* vol. xiii. 1847, p. 13; vol. xlviii. 1864, p. 36. There seems an error in Dr. Cutter's statement of his results. He tabulates 14 deaths, but only reckons 13.

of the sac, nine of hæmorrhage, five of peritonitis, one of pelvic abscess, one of diffuse inflammation, three of prostration and exhaustion, one of pleurisy, two of tetanus, and one of delirium tremens. Two of the remaining cases were unaccounted for. In successful cases, the earliest period of the separation of the ligature was the tenth, the latest the sixty-second day. In fifty-two cases it came away before the twentieth day, and in thirty others before the thirtieth.*

ABDOMINAL ANEURISM.

Many of the pulsating tumours which are found in the false pelvis are of a cancerous nature; many of those which are undoubtedly aneurismal are seated upon the aorta, too high for surgical treatment. Thus, both the diagnosis and treatment of such tumours demands the most careful consideration. I can add nothing on the general question of the diagnosis between aneurism and pulsatile tumour of bone to what will be found above; and will here merely remark that the points most likely to be marked as distinguishing a tumour of the os innominatum from an aneurism of the iliac or gluteal artery would be the presence of swelling on both sides of the bone, and the appearance of cancer-cells in the urine, together with the equal beat of the pulse on the two sides. It would never be agreeable or advisable to commence an operation on the iliac vessels without having plainly heard the aneurismal bruit. But Mr. Moore's case above referred to (p. 453) shows that even this symptom may be deceptive.

As to the treatment of an aneurism in the belly, three plans suggest themselves: the employment of compression to the artery above, the use of medical means only, or the Hunterian operation.†

The successful treatment of abdominal aneurism by compression was first carried out by Dr. Murray of Newcastle-upon-Tyne,‡ under chloroform; pressure being kept up on the first occasion for two hours and on the second for five hours, with permanent success. In a case under the care of Dr. Heath of

* A successful case of ligature of the external iliac with silver wire has been recorded by Dr. Martin in the *Am. Journ. of Med. Sc.* Oct. 1866 p. 580.

† The old method has been adopted here also; but its results, I believe, have been, and would always be, uniformly fatal.

‡ *Med.-Chir. Trans.* vol. xlvii. p. 187. Dr. Murray speaks of the experiment of curing abdominal aneurism by pressure as one previously unthought of—not having met with the recommendation of the plan in the first edition of his work.

Sunderland,* pressure had been kept up irregularly for ten hours, when the patient fainted under chloroform. The symptoms were as bad as ever. He was urged to bear a final effort without chloroform. This he did, and at the end of twenty minutes, when he declared he could bear it no longer, the aneurism had become solid and had ceased to beat.

The Hunterian operation for abdominal aneurism may be practised on the common iliac artery, or on the lower part of the aorta. In some cases it may perhaps be possible to secure the upper part of the external iliac for aneurism situated above the groin; but this operation has been already described.

The operations for securing all the iliac arteries are similar in principle, and identical in most of their details. The same incision serves to reach them all—only to reach the common or internal iliac the incision must extend further upwards, and must be longer, in consequence of the greater depth at which the internal iliac lies, and the higher position of the common iliac. Hence the surgeon can determine during the operation which vessel he will select, according to the extent of the tumour and the appearance of the artery when exposed.†

In applying a ligature to the *common iliac*, the operator must remember the situation of the large veins which run with the artery of each side; and he must be careful to look out for the ureter, both to avoid including it in the ligature (of which, however, there is little risk), and to avoid doing it any other damage.

The common iliac may also be tied by an operation behind the peritonæum similar to that which is used in experimental operations on the lower animals for tying the abdominal aorta.

Sir P. Crampton's case is well known, and his operation is a good illustration of the method of reaching the artery from above the tumour. An incision was made from the end of the last rib obliquely forwards and downwards to the crista ilii, and then curved forwards above and parallel to the crest of the ilium, terminating at the anterior superior spine. The muscles and fascia transversalis were cut through at the bottom of the incision till the subperitoneal interval was reached, and then the peritonæum being held back by the front of the finger, a probe-pointed bistoury was run along the back of the finger, and so, by repeated strokes of the bistoury the muscles were divided to the extent of the external wound. Sufficient room was thus obtained to pass in the whole hand, and raise the

* *Brit. Med. Journal*, Oct. 5, 1867.

† Guthrie, *Commentaries*, p. 262.

peritonæum and intestines from the fascia iliaca. The parts were then plainly visible, and the vessel easily secured.*

The artery may also be reached by an incision through the peritoneal cavity, similar to that by which Sir A. Cooper cut down upon the abdominal aorta; but this plan should never be followed if either of the others are practicable.

The statistics of the ligature of this great vessel are most gloomy, the recoveries having been only exceptional. In the *American Journal of Medical Sciences* for July 1860, Dr. Stephen Smith collected all the cases known then to have occurred, thirty-two in number,† of which only seven terminated in recovery; and in one case at least the patient appears to have died under the operation. The causes of death were noted in nineteen cases; and it is remarkable that gangrene was the alleged cause in only three instances; the others were, ‘exhaustion’ eight, hæmorrhage six, and peritonitis two. In successful cases, or cases uncomplicated by hæmorrhage, the ligature may be expected to separate in about three weeks.‡

Ligature of the abdominal aorta.—Sir A. Cooper’s case, the first in which the abdominal aorta has been tied, is well known.§ The patient was suffering from aneurism, which appears to have involved the left common iliac artery, and the vessel below it to some extent. It had burst through the skin, and the

* It is worth while to quote Sir P. Crampton’s forcible description. ‘The parts were unobscured by a single drop of blood. There lay the great iliac artery, nearly as large as my finger, beating awfully, at the rate of 120 in a minute, its yellowish-white coat contrasting strongly with the dark blue of the iliac vein which lay beside it, and seemed nearly double its size. The ureter, in its course to the bladder, lay like a white tape across the artery; but in the process of separating the peritonæum, it was raised with that membrane, to which it remained attached.’ (*Med.-Chir Trans.* vol. xvi. p. 162.)

† Dr. Smith has divided his cases into four groups: 1, for arrest of hæmorrhage in wounds, or in surgical operations, eleven cases, only one of which recovered; 2, for aneurism, fifteen cases, ten deaths; 3, for pulsating tumour mistaken for aneurism, four cases, one recovery; 4, to obviate hæmorrhage in an operation in one case, and in an aneurism for anastomosis in the second, two cases, both of which died. It is perhaps hardly presumptuous to say, after this experience of the operation, that most of the cases never ought to have been submitted to ligature; and that the operations in the first class would now be unjustifiable.

‡ Mr. Erichsen adds seven cases, and reckoning as successful one of the cases tabulated by Smith as fatal (since the patient appears to have died from a different cause after the closure of the wound), he gives twenty-nine deaths and ten recoveries. (*Sc. and Art of Surgery*, vol. ii. p. 103.)

§ *Surgical Essays*, by Cooper and Travers, vol. i. p. 128.

patient was greatly reduced by hæmorrhage. Sir A. Cooper endeavoured, by making a small puncture into the aneurism which he could plug with his finger, to reach the opening of the artery, with a view of tying it on both sides of its communication with the sac—the operation since practised by Mr. Syme. But as he could not reach the vessel by this means, he determined to give the patient the ‘only hope of safety’ which remained for him, by putting a ligature round the artery above the tumour—the aorta. The operation was accomplished by an incision through the linea alba, three inches in length, its centre corresponding to the umbilicus; the peritonæum was opened to about the extent of the skin-wound; the intestines, which were completely empty,* did not protrude; the finger was passed down between their convolutions on to the spine, where the aorta was felt beating violently. The peritonæum was then scratched through with the finger-nail, and the point of the finger was insinuated below the vessel. The aneurism-needle was then conveyed round the aorta, and the ligature tied. In doing this, great care was necessary, to avoid including the intestine or omentum. Sir A. Cooper’s patient survived forty hours; Mr. James’s died the same evening. These cases, to say nothing of the numerous instances in which the artery has been successfully tied in the lower animals, certainly show the possibility of survival after the operation; and accordingly the operation has been repeated several times,† not, however, on Astley Cooper’s plan, but by an operation similar in most respects to Sir P. Crampton’s on the common iliac artery; that is to say, by a free incision through the abdominal walls, somewhat far back, carried down to the fascia lining them, then making a cautious division of this fascia to the extent of the wound, gradually pushing over the peritonæum and intestines, and directing the fingers towards the front of the spine, where the pulsation of the great artery will easily be

* Sir A. Cooper adds the remark, that in this operation it is essential to have the bowels well emptied; and the truth of this observation was exemplified in the next case in which the artery was tied, by the great trouble experienced by the operator (Mr. James) in consequence of the tympanitic condition of the intestines. (*Med.-Chir Trans.* vol. xvi. p. 1.)

† By Murray, *Med. Gaz.* 1834, vol. xiv. p. 68; Monteiro, *Schmidt's Jahrb.* 1843; South, *Lancet*, 1856, vol. ii. p. 222; McGuire, *Am. Journ. of Med. Sc.* Oct. 1868, p. 415; and with a temporary compressor by Dr. Stokes jun., of Dublin (see page 485).

felt. But though it is easy to feel the artery, there is much difficulty in getting the finger round it, and in separating it from the important parts which lie around.

Many most interesting questions present themselves in considering the justifiability of this daring experiment in operative surgery. Our space will not allow of their adequate discussion; but the main considerations must be summarily stated. First, is there really any rational prospect of recovery? One of the patients (Monteiro's) survived ten days, so that it would be rash to deny that there is. Still we must not forget that such an operation is never undertaken except upon a patient in the extremity of a disease probably affecting the whole arterial circulation, one in a very different condition from a healthy animal, or even a healthy man. Secondly, allowing the theoretical possibility of recovering, is the practical chance of it ever equal to that of spontaneous cure? Sir A. Cooper's case certainly was one, to judge by his description, in which such a cure was impossible, since he had laid open the tumour in an unsuccessful attempt to perform the old operation; and hæmorrhage must soon have occurred, and could hardly have failed to prove instantly fatal, so that some operation was inevitable. But, thirdly, is it ever necessary to secure the aorta itself? Mr. Guthrie believes, on the contrary, that when an operation is possible, the common iliac artery above the tumour could always be reached by making the incision on the opposite (sound) side, as if to tie the common iliac of that side, and then passing over from that artery, when it has been found, to the one on the side of the disease.* The old operation might be attempted, but would be very liable to fail, from the fact of the sac passing into the pelvis, and so perhaps pressing the opening of the artery out of sight; or galvano-puncture might be tried in a case which seemed suitable for it. In such desperate circumstances probably any treatment would be unavailing to prolong life; but the risk of doing harm by any treatment is not great, since the patient's life will not last under any circumstances more than a few days. On the whole, however, the natural repugnance of surgeons to perform great operations which cannot be expected to succeed, will either banish this altogether from practice, or restrict it to a very few exceptional cases.

* *Commentaries*, p. 265.

GLUTEAL ANEURISM.

Pulsating tumours in the buttock, of spontaneous origin, are usually found to be of a cancerous nature, and connected with the innominate bone; but aneurism of the gluteal or sciatic artery may occur unconnected with wound, and in the Museum of the College of Surgeons there is a preparation by John Hunter of an aneurism of the internal pudic artery. The diagnosis, however, should be very clearly established before the extremely dangerous measures necessary for the treatment of gluteal aneurism are recommended. The points to which principal attention would be directed would be, whether any tumour is present in the iliac fossa; whether the bruit is of the true aneurismal character; whether any bone can be felt in the envelope of the tumour; whether the pulsation resembles that of aneurism (expansive) or that of pulsatile tumour (rapid and heaving); and, finally, whether any sign of constitutional affection can be detected. Mr. Guthrie's case,* however, shows that the greatest experience in aneurism cannot always insure against errors of diagnosis.

If the existence of aneurism appears certain, two courses are open to the surgeon; viz. to perform the old operation with the precautions against sudden and excessive hæmorrhage which Mr. Syme adopts, or to tie the internal iliac artery. The former course can only be recommended when the aneurism is of traumatic origin, since in that case the artery will be sound, and the wound in it will be within reach; while in a spontaneous aneurism, besides the risk of putting the ligature round an unsound artery (which, under the circumstances, is a minor consideration), the orifice of communication may be within the pelvis, and the old operation absolutely impracticable. Mr. Syme relates an example of each form of aneurism,† and each method of treatment, which was successful in both instances. No further description is necessary here of Mr. Syme's method (or revival of Astley Cooper's method) of performing the old operation, as it has been already described on p. 460. I shall, therefore, proceed to describe the ligature of the internal iliac artery.

* *Med.-Chir. Trans.* vol. xxviii. p. 308.

† *Obs. on Clinical Surgery*, 1861, pp. 165-173.

The internal iliac should only be tied for aneurism of one of its branches, or for a wound within the pelvis in which pressure will not stop the bleeding. In this case, however, the operation, which is one in itself of great danger, should be practised only after very careful deliberation. The artery has been secured in order to stop hæmorrhage from a wound in the buttock; but the practice has been justly censured by Mr. Guthrie.*

The operation much resembles that above described for placing a ligature on the common iliac (see p. 615). Having, by the steps there prescribed, arrived at the lowest point, or bifurcation, of the common iliac artery, the operator must follow down the internal iliac into the pelvis, his finger being laid across the external iliac vessels, which may, if it be practicable, be shielded by a curved spatula from all chance of injury. It is desirable to place the ligature at a distance of about $\frac{1}{2}$ — $\frac{3}{4}$ inch below the bifurcation. The vein lies behind the artery. The spot at which the ligature is to be placed having been fixed, the surgeon scratches the artery free from its connections with his finger-nail, and then proceeds to pass the ligature; in doing which Mr. Guthrie says that it is desirable if possible to see the vessel, and for this purpose directs that the lips of the wound be retracted. The artery, however, lies at so great a depth that it can only be brought into view if the person be spare. Great care accordingly is required to avoid wounding the peritonæum, the ureter, and the vein which accompanies the artery. The termination also of the inferior mesenteric vessels (superior hæmorrhoidal) may be injured in operating on the artery of the left side.

The cases in which this operation is required must be very rare. Of seven cases contained in the *American Journal of Medical Sciences* (vol. xiii.), three recovered, and four died. Mr. Syme's successful case is to be added to the recoveries and a case by Mr. Atkinson to the list of deaths; † so that the operation has been sufficiently successful to encourage its repetition.

T. HOLMES.‡

* *Commentaries*, p. 270.

† Erichsen, op. cit. p. 107.

‡ The Sections on Digital Pressure, Manipulation, Galvano-puncture, Coagulating Injections, Arterio-venous Aneurism, and Cirroid Aneurism, are re-edited from the originals written by Mr. Hart.

NOTE TO THE ESSAY ON ANEURISM.

LIGATURE OF THE LEFT SUBCLAVIAN IN THE FIRST PART OF ITS COURSE.

SINCE the foregoing essay was in type, I have been favoured, by the kindness of Dr. Lewis Sayre of New York, with the particulars of the case referred to on p. 566 (note), in which Dr. J. Kearney Rodgers of that city tied the left subclavian artery within the scalenus muscle. The case will be found detailed in the *New York Journal of Medicine* for 1846.

The patient was a man aged 42; the disease had existed for four months, and formed a pulsating tumour the size of a small hen's egg, rising about two inches above the left clavicle, extending externally to the outer third of the bone, and internally covered by the outer edge of the sterno-mastoid muscle. The cutaneous veins were very much enlarged over it. He was troubled with severe pain, preventing sleep, down the course of the nerves of the brachial plexus, and the arm and hand were cedematous. The pulse was unaffected. He was kept under treatment, chiefly by means of venesection and digitalis, for a month, but the tumour steadily increased, and the man's sufferings were so acute as to render him anxious to submit to any operation, however dangerous. At a consultation, the surgeons present, of whom Dr. Mott was one, declined to recommend the operation, but left it to Dr. Rodgers's judgment, who operated on October 14, 1845.

He thus describes the operation:—

‘An incision was made three inches and a half in length on the inner edge of the mastoid, terminating at the sternum, and dividing the integuments and platysma myoides.

‘This was met by another extending along the sternal extremity of the clavicle, about two and a half inches. This last incision divided a plexus of varicose veins passing, in the integuments covering the clavicle, to the subclavian. Free bleeding taking place from their cut and patulous extremities, it became necessary to check it by ligature.

‘The flap of integuments and platysma myoides was now dissected up, and the lower end of the mastoid laid bare; a director was passed under this muscle, and the sternal portion and half of the clavicular divided by the bistoury. This muscle was now turned up, and the sterno-hyoideus muscle, the omo-hyoideus, and the deep-seated jugular vein were seen covered by the fascia.

‘On turning up the mastoid, a portion of the aneurismal sac strongly pulsating was brought into view, overlapping about half the width of the scalenus, forming

now the outer part of the track through which I was to pass; showing fearfully one of the dangers of the operation, which from my previous examinations of the part, I had of course anticipated.

‘The fascia being divided by the handle of the scalpel and the fingers, I passed in contact with the deep jugular on its outer side to the inner edge of the scalenus anticus, intending, for the purpose of avoiding as much as possible all danger to the thoracic duct, to reach this muscle fully half an inch above the rib, rather than at its insertion. I now felt distinctly the phrenic nerve running down on the anterior surface of the scalenus, and was confident that I should be able to avoid any injury to it. Having attained the inner edge of the scalenus anticus by pressing downwards with the finger, I soon discovered the rib, and after some little search easily found the subclavian artery. By pressing it against the rib, all pulsation ceased in the tumour, and by removing the finger pulsation returned.

‘I now felt that great care was necessary to detach the artery, and avoid danger to the pleura and thoracic duct. In accomplishing this part of the operation, I at first tried Sir Philip Crampton’s instrument, but ascertaining that I could better carry the ligature around the artery, and bring up its end, by the invention of Drs. Parish, Hewson, and Hartshorne, of Philadelphia (long since given to the profession by them, and lately claimed by Mr. L’Estrange of Dublin), I accordingly adopted that instrument.

‘This part of the operation, it will be imagined, was not very readily accomplished. The great depth of the vessel (nearly the length of my finger) and narrowness of the wound, prevented a very easy management of instruments. The point was introduced under the artery, and soon directed upwards so as to avoid injury to the pleura. I readily tied the ligature, and tightened it with the forefinger in the bottom of the wound. All pulsation immediately ceased in the aneurism and the arteries of the extremity.

‘The patient complained of no pain or unusual feeling in the head, as might have been expected from so suddenly changing the current of so large a quantity of blood.’

He went on well, with the exception of a slight erysipelatous attack, until the tenth day (October 23), when a cough came on, and he complained of flashes of light before his eyes; the left pupil was noted as being contracted; and on the following day ptosis came on on that side. Secondary hæmorrhage commenced on the thirteenth day, and proved fatal on the fifteenth.

Post-Mortem Examination eighteen hours after death.

The wound was filled with coagula and sponge, which had been introduced for the purpose of making pressure. The blood was already in a state of partial decomposition.

The dissection was carefully performed, exposing the different layers of muscles. The lower incisions made at the operation were found to include three-fourths of the mastoid, leaving a small portion of the clavicular portion undivided.

Below this the aneurismal sac and the scalenus anticus formed the outer and posterior wall of the wound. The inner wall was formed of condensed cellular tissue covering the carotid artery, jugular vein, thoracic duct, and the edges of the thyroid muscle.

At the bottom was the subclavian artery, completely divided by the ligature, which was found free in the coagula. The cellular tissue of all the parts around the wound was condensed by adhesive inflammation, rendering the dissection exceedingly tedious and difficult. The jugular vein, which skirted the inner wall of the wound, was obliterated and filled with fibrinous coagula.

Opposite the track of the ligature the vein was contracted to a cord, and impervious as far as its junction with the subclavian. The vena innominata and subclavian were normal.

The pleura at the bottom of the wound presented a large irregular lacerated opening, communicating from the wound with the left pleural cavity, which was filled with coagulated blood. This formed one large uniform coagulum, and had every appearance of being of rapid and recent formation; the membrane around was thickened. On exposing and tracing the subclavian artery, it was found that the ligature had been applied about one and a quarter inches from its origin at the aorta, and immediately at the root of the vertebral, on its cardiac side. The artery had been completely divided by the ligature, which as mentioned above was found loose in the wound. The stump of the subclavian, between the aorta and ligature, presented the appearance of a round solid cord, about an inch and a quarter long, and impervious to liquids and air.

The external coat of the stump was thickened and adherent near the ligature to the surrounding tissues, by adhesive inflammation. On laying open the vessel longitudinally it was found that a firm fibrinous coagulum occupied the vessel, and was adherent firmly to its inner coat for three-quarters of an inch; near the aorta, the coagulum was softer. The coats of the vessel were moderately thickened, and presented a small patch of atheromatous deposit about the third of an inch from the tied end. Around this deposit the adhesion seemed as perfect as at any other part.

Beyond the ligature, the artery presented a different appearance. No plug other than a soft coagulum of blood occupied its cavity, and it presented much less evidence of adhesive inflammatory process in its coats. The vertebral was given off immediately at the point of ligature, and was open, containing a thin blood coagulum like the one in the subclavian. These were drawn out with ease, and evidently had formed during the last moments of life.

About one-third of an inch from the vertebral was the internal mammary. These vessels were all patulous and healthy. About half an inch from the thyroid axis commenced the dilatation of the artery to form the aneurismal sac.

This tumour was about the size of a small orange, and had involved in its growth part of the scalenus anticus, the cervical nerves going to form the cervical plexus, the surrounding cellular tissue, and the glands. The aneurism was completely blocked up with coagula, and the axillary artery which emerged from its distal side was plugged with a fibrinous clot exactly similar to the one in the stump of the subclavian, though perhaps not so perfect. It appeared sufficiently so, however, to obliterate entirely the calibre of the vessel. The plug extended some distance down the axillary artery.

The thoracic duct, which had been injected with wax from the abdomen, was found uninjured. The aorta was thickened, and its coats irregular from a considerable deposit of atheromatous matter in its tissues.

The heart was somewhat larger than natural, but apparently sound. The other organs were not examined.

Dr. Rodgers's observations on this most interesting and important case are well worthy of perusal. They are as follows:—

'Although a decided majority of the consultation agreed as to the propriety of the operation of securing the artery for aneurism, still, as my colleagues kindly left it with me to decide whether it should be undertaken, I felt it incumbent on me to investigate the subject with great care, and accordingly gave it my most sedulous attention. I was the more anxious, because, in the only case in which the attempt had been made by Sir Astley Cooper, in 1809, that eminent surgeon failed to secure the vessel, and is said to have entertained apprehensions that he had wounded the thoracic duct.

'I had always considered it as a perfectly justifiable operation, and one that a careful surgeon conversant with anatomy could accomplish, if the tumour were of moderate size.

'The want of success in the four or five operations on the right subclavian in its first stage did not discourage me, nor did they alter my opinion.

'The difference in the anatomy of the right and left arteries was so very great, that I did not consider it fair to argue that a similar result was to follow on the left side.

'The greater depth of the left, indeed, rendered the operation more formidable, but, if accomplished, not less likely to succeed.

'The point where the ligature must necessarily be applied on the right side is but a quarter or at most half an inch from the innominate and the coming off of the carotid, so that it could scarcely be expected that a coagulum would form sufficiently firm to adhere to the vessel, and resist the force of the heart's action. Besides, too, the greater force of the circulation on the right side was additionally unfavourable to success on that vessel, and, therefore, is an additional reason for distrusting an argument drawn from a parallel between the two.

'In examining anatomical and surgical authorities, I found the opinion prevalent among almost all British authors, that the operation on the left side was "impracticable."

'Colles, the eminent Irish surgeon who first tied the right subclavian in its first stage, says: "This operation, difficult on the right, must be deemed impracticable on the left subclavian. For the great depth from the surface at which this vessel is placed, the direct course which it runs in ascending to the top of the pleura, the sudden descent which it makes from this to sink under the protection of the clavicle, and the danger of including in the same ligature the eighth pair of nerves, the internal jugular vein, or the carotid, which all run close to and nearly parallel with this artery—these all constitute such a combination of difficulties as must deter the most enterprising surgeon from undertaking this operation on the left side.' (*Edinburgh Med. and Surg. Journal*, January 7, 1815, p. 23.)

'Harrison,* Flood,† Guthrie,‡ and Quain § all coincide in this opinion.

* *On the Anatomy of the Arteries*, vol. i. p. 125. Dublin, 1833.

† *The Surgical Anatomy of the Arteries*, p. 84. London, 1839.

‡ *On the Diseases and Injuries of the Arteries*, &c., p. 396. London, 1830.

§ *Anatomy*, 3rd edition, p. 492. London.

'The opinions of those eminent anatomists and surgeons being so decidedly against the possibility of the operation, it was only left for me to examine with great care the surgical anatomy of this vessel.

'Having had the thoracic duct injected with wax, I repeatedly dissected the parts concerned, and operated in every way that suggested itself to me as likely to present any advantage.

'My opinion of its feasibility was thus confirmed, and having never entertained any doubts of its propriety, I accordingly undertook it.

'I regret, indeed, deeply, the death of my patient; but the appearances presented on examination after death have only strengthened the opinion I had previously formed, and have encouraged me to undertake it, with some slight variations, should another case ever present itself.

'It has often happened with important operations that many of the first cases have been unsuccessful, while the carefully noted observations made on dissection have led to different modes of operating, and more uniform success.

'Previously to the performance of this operation, many entertained doubts whether the force of the circulation so near the heart in so large a vessel would not prevent the formation of a coagulum, and of course interfere with the obliteration of the vessel. These doubts have now been removed, and I consider that all reasonable objections fall with them, except those arising from the anatomy.

'Danger to the thoracic duct and pleura are, in my opinion, the most serious of these, for, with ordinary coolness and care, there will be little danger of including the pneumo-gastric and phrenic nerves, or carotid artery, in the ligature. The veins may be lacerated by great roughness, but can scarcely be included.

'The thoracic duct, I think, can almost always be avoided by reaching the inner edge of the scalenus half or three-quarters of an inch above its insertion, and then pressing the finger down towards the rib. The duct is thus kept out of the way of laceration by the finger, and afterwards by the aneurismal needle. I am aware that this duct varies in its course, but this direction I am confident will usually secure its safety. By adopting it in the many times I operated and dissected the parts in the dead body, it was uninjured.

'The artery lies in contact with the pleura, the laceration of which might be attended with very distressing and dangerous consequences.

'A careful introduction of the aneurismal needle, and soon turning up its point, will usually secure the safety of this membrane. In none of my operations on the dead body, where it was performed in this way, was it injured.

'The hæmorrhage in this case came from the distal end of the artery, and the very free and direct anastomosis of the internal carotid at the base of the brain with the vertebral, induce me to think that it was the latter vessel which transmitted the blood. Some indeed may have come through the thyroid axis, but I consider the former mode more direct.

'Should this operation be repeated, I would suggest securing the vertebral, and if possible the thyroid axis, by ligature.

'The difficulties are indeed thus increased, but not insurmountable.'

I have had the greatest pleasure in laying the history of this case (which is too little known in England) before the readers of this work. Whether it justifies the operation in

any given case must still be a matter of individual opinion. It certainly shows the opinion ordinarily entertained of the impracticability of the operation to be erroneous; but we cannot avoid seeing that the difficulties, and even the anatomical dangers of the operation (terrible and almost insurmountable as these latter are *) do not exhaust the objections to the proceeding. For in this as in all previous cases which survived those dangers, the cause of death has been secondary hæmorrhage. Dr. Rodgers's suggestion of tying the large branches which come off near the distal side of the ligature, is eminently worthy of trial. Still more is it to be hoped that some method may be found for obliterating arteries without dividing them. If the latter desideratum could be realised, I should expect the ligature of these great arteries (innominate, first part of subclavian, and possibly abdominal aorta) to take its place among the recognised and successful operations of modern surgery.

* In this very case, if I read the account right, the probability is that the pleura was opened during life. It is true the pleura has been known to have been opened in operations on the subclavian arteries in cases which have nevertheless proved successful (vide p. 560).

T. H.

AFFECTIONS OF THE MUSCULAR SYSTEM.

ALTHOUGH muscles are so much exposed to accidents and violence, they are not readily injured ; nor, considering their high organisation, are they frequently the seat of disease. Muscles may suffer from contusions, strains, rupture, and wounds of different kinds. Severe contusions are frequently followed by temporary loss of power in the muscle ; this, together with the extreme pain in any attempt to move the part, particularly in the neighbourhood of the large joints, sometimes leads to the suspicion of more serious injuries, as fracture or dislocation. Strains of muscles are often followed, especially in later life, by pains of a lasting and troublesome character, partaking of the nature of rheumatism. Muscle may be ruptured either from external violence or from the too energetic action of its own fibres ; this latter occurrence is by no means a common one, especially that in which the entire muscle is torn across. In the living body, muscle offers a greater resistance to a force tending to rend it than either tendon or bone ; and when it does give way, it is for the most part at its point of junction with the tendon. Sédillot* says, that in twenty-eight cases of rupture of muscles, thirteen were ruptured at this point.

The power of resistance in a sound and healthy muscle in a state of full tonicity is enormous ; and many interesting comparisons and calculations on this subject will be found in Borelli, *De motu Animalium*. Percy† relates the case of a person with wry neck, who was suspended by the head, with a view of putting the muscle on the stretch ; the result was separation of the muscle from its insertion, but no laceration of its fibres : and in a case in which the thumb was torn off, the tendons were drawn out, but the muscles were left uninjured, except at the point of junction with the tendon. We are all

* *Mém. sur la Rupture musculaire* ; Mém. et Prix de la Soc. de Méd. de Paris, 1817, p. 115.

† *Journal général de Médecine*, vol. lxi.

familiar with the fact, that the tendon of the rectus femoris and the tendo Achillis give way rather than the fibres of their respective muscles. With the loss of its vital contractile power, muscle loses its advantage over tendon, and the experiments of Richerand and others fully establish the fact, that after death muscle is more easily ruptured than tendon. We observe this when a limb is forcibly straightened from the bent position after the muscles have become unusually rigid from convulsions before death; here laceration of the muscles and not of the tendons, takes place.

Though muscle in the living body is not often ruptured, yet cases of rupture occur sufficiently often to have given most of us one or more opportunities of witnessing it. Sédillot has recorded no less than twenty-eight cases of entire or partial spontaneous rupture of muscles; but he observes, that no voluntary act can occasion a rupture of their fibres, however powerful the effort may be, and this for two reasons: 1st, because, under the influence of the will, all the fibres of a muscle, and the muscles associated with it in its action, contract uniformly, simultaneously, and in a regular order, to overcome a resistance; and 2ndly, because at the moment that the will perceives that the power opposed to it is greater than its efforts can overcome, it ceases to strive further. Rupture, therefore can only take place when, in some involuntary or instinctive effort, as in the endeavour to recover the equilibrium in a false step, or from some similar cause, the whole force is thrown in a violent and unexpected manner upon one or two muscles, or even on a few fibres. Among the cases collected by Sédillot, is one in which the rectus femoris was ruptured. In another case, the psoas magnus muscle was found ruptured after death, the patient having died from inflammation and suppuration following the accident. The complete rupture of the biceps muscles of each thigh occurred in a man falling from a height; and the two recti abdominis were ruptured at their upper part in a young man, in the struggle to save a tray of cement as he was falling from a platform.

It more frequently happens that a few fibres only of a muscle are ruptured, and this usually occurs in the gastrocnemius.* Muscles are sometimes torn across in violent paroxysms of muscular spasm, as in tetanus. In these cases the ends of the muscle, from the violence of the retraction, are thrown into considerable swellings.

* Wardrop, *Med.-Chir. Trans.* vol. vii.

In a case of acute traumatic tetanus, under Larrey, the man was immersed in cold baths, after each of which the convulsions and muscular contractions were most severe, and he died in three hours; a swelling, however, had been previously observed below the umbilicus, on the right side. On a post-mortem examination, it was found that the tumour was occasioned by the retracted ends of the rectus, which was entirely torn across. The space between the two ends of the muscle was filled with blood. Mr. Curling describes a case in which portions of both recti abdominis were ruptured by tetanic convulsions (one of the specimens is in the Museum of the College of Surgeons). Mr. Gray exhibited, at the Pathological Society, the rectus muscle of a patient who had died of tetanus, in whom almost complete transverse laceration of the muscle had taken place. In Mr. Earle's case of tetanus, described in *Med.-Chir. Trans.* vol. vi., one of the psoas muscles was partially ruptured. Boyer relates the case of a strong man admitted into La Charité with 'bilious fever;' an emetic was given him, and whilst vomiting, acute pain was felt a little below the middle of the left rectus abdominis muscle. On examining the part, there was neither tumefaction nor discoloration of the skin, but an indentation, into which the fingers could be placed, was felt. The man died; and the muscle was found completely torn across, the two ends being an inch apart, and the space between filled with blood.

The rupture of a muscle is accompanied by extreme pain, resembling that occasioned by a smart blow from a whip or stick, and often by a distinct sound like the snapping of a cord; all motion of the part is either impossible, or is accompanied by such severe pain, with spasmodic twitching, as to cause the patient to desist. If the muscle be a superficial one, a deep indentation will be found at the seat of rupture, produced by the retraction of its divided ends; and often a considerable swelling, proportioned to the vigour of the contraction of the torn fibres, as in tetanus; and as there is always extravasation of blood, much discoloration of the skin will follow. The indentation and extravasation are not apparent, however, in ruptures of the deep muscles, by which their diagnosis is rendered less clear. If the rupture be discovered early, and judiciously treated, a sufficient approximation of the divided ends will result, good union will follow, and the function of the muscle will be restored. If, on the other hand, it be overlooked or maltreated, or if it occur in a part where proper measures cannot be employed to approximate the ends of the muscle, as in some parts of the trunk, in ruptures of the deep muscles about the hip and shoulder, &c., it will be found that a wide separation exists, and that the ends of the muscle instead of uniting, have become attached to the parts in the immediate neighbourhood, and the use of the muscle is consequently lost.

The treatment consists, 1st, in placing and retaining the part

in a position most favourable for relaxing the muscles ; and 2nd, in approximating the separated ends to one another by even compression, which we know exercises so great a power in controlling and modifying the excess of contraction in the muscles, in fractures, &c. As regards the first, this is easily accomplished in the limbs : thus in rupture of the rectus femoris the knee is straightened, and the limb is raised to an angle with the body, as in fractured patella ; but where the rupture occurs in the trunk, this cannot be done so readily ; yet in the case above mentioned, in which both recti abdominis were ruptured, a good union was effected by keeping the patient in a sitting posture, the body being bowed forward, together with proper bandages.* The second is accomplished by an even and uniform compression of the muscles by means of carefully-applied flannel bandages, or laced belts, aided in some cases by a strip of leather or gutta-percha. At the end of from a fortnight to three weeks, the union is generally completed. The process of union is similar to that of other structures ; the effused blood is absorbed, plastic lymph is poured out, which assumes by degrees the firm and resisting character of tendon, muscular fibre itself being never reproduced. When a muscle, with the integument and parts around, is divided, it retracts to a greater extent than where the muscle alone gives way, from being deprived of its collateral support. This, in conjunction with an open wound, renders it extremely difficult to approximate the retracted ends of the muscle, and to find means for retaining them in a proper position ; hence it will be found that wounds extending through muscles are followed by nearly complete loss of their use, the great chasm between their ends being filled up by granulation. It is recommended to endeavour to bring the ends together by sutures. These, with a position favourable for the approximation of the ends, and such encircling supports as can be employed where a wound is present, may do much towards restoring the muscle to a certain amount of usefulness.

Inflammation of muscle.—Independently of rheumatism, muscles may be the seat of inflammation from various causes, both simple and specific, which may terminate in abscess, or in some morbid changes of structure, to be described hereafter. Inflammation followed by abscess occurs occasionally in the parietal

* Richerand, *Nosographie chir.* vol. ii.

muscles of the abdomen, arising either from some injury or without apparent cause. It appears first as an extremely painful, and more or less circumscribed swelling, distinctly felt below a portion of the muscular planes: after a time obscure fluctuation is perceived; pain is now very great, especially on the least movement, accompanied by irritative fever. On laying open the abscess, pus, discoloured and somewhat offensive, escapes, the symptoms quickly subside, and the cavity readily fills up and heals.

Purulent deposits in the pectoral muscles, extending to the intercostal muscles and diaphragm, occurred in a case described by Mr. Hacon in *Path. Trans.* vol. v. p. 329. The patient had rigors and other symptoms of fever ten days before his death, with great pain in the right hypochondriac region; formation of matter was suspected, and pus followed the introduction of a needle. There were no purulent deposits in any viscus.

Secondary deposit of pus sometimes takes place in muscles as well as in other structures. A case is given of phlebitic suppuration in muscle, originating in what he terms puerperal rheumatism, by M. Cruveilhier.*

Inflammation may occur in muscles as a symptom of secondary, or rather tertiary, syphilis. In a paper read before the Royal Medical and Chirurgical Society in January 1845,† Mr. Tatum described a group of three cases, two of which were associated with other symptoms of constitutional syphilis, whilst the history of the third case was obscure. The disease, which he had not seen described before, appeared in the form of rounded enlargements in the left sterno-cleido-mastoid muscle; there were three swellings in two of the cases, and two only in the other; in one of these there was also an enlargement in the tendinous origin of the muscle; the tumours were evidently formed in the substance of the muscles, and were nearly of the size of a pigeon's egg, and gave a singular beaded appearance to the muscles; there was stiffness, with much tenderness, in the part, and great pain when the muscle was in action; the skin was neither adherent nor discoloured; the disease was slow in its progress, and had remained nearly stationary for some months. All the cases occurred in females, probably from the neck being more exposed than in men; in each case the effects of the iodide of potassium were manifest. In the first case the patient obstinately refused to take the iodide of potassium, in consequence of which mercury and various other remedies were tried without any good effect. After some time

* *Path. du Corps humain*, fasc. 17.

† *Lancet*, Feb. 1, 1845, p. 136.

she consented to take the iodide of potassium; from two to three grains were administered thrice daily, and the iodine ointment was applied externally; the tumours soon began to diminish, and in less than six weeks completely disappeared. The other two cases were similarly treated, with complete success; but in one of them the patient was obliged to lay aside the remedy for a time, during which it was remarked that the tumours became stationary; on her resuming the medicine, however, all remains of the disease quickly left her. What constituted the swellings could not of course be ascertained from these cases; but a case occurred some time after, in which there was a tumour in the middle of the biceps muscle, so hard and defined as to induce the surgeon to proceed to its removal by operation, when, on cutting into the fibres of the muscle, no tumour was visible, but the muscle in that part was congested and infiltrated with a grayish kind of lymph, great part of which oozed away with much blood, all the swelling subsided, and the wound healed, leaving no enlargement. Much light has been thrown upon the nature of these affections of the muscles and the changes they undergo by M. F. Bouisson of Montpellier, under the title of *Tumeurs syphilitiques des Muscles*.* According to him, both tendons and muscles are the seats of syphilitic tumours and contractions, which occur in conjunction with other symptoms of constitutional syphilis. He has observed these tumours in the glutæus maximus, the vasti, trapezius, the sterno-cleido-mastoideus; also in the muscular structure of the tongue, lips, and pharynx. With regard to the treatment, he for the most part found the iodide of potassium, given internally, with the external use of the iodine ointment, very effectual in removing the tumours, except those of the tongue and pharynx, which were very obstinate; in these cases the muriate of gold, in doses of from $\frac{1}{16}$ th to $\frac{1}{8}$ th of a grain, was given with success. M. Bouisson was fortunate in having opportunities of seeing this disease in its advanced stages, as well as the stage above described. He found the enlargement continue with little change, except under the treatment of the iodide of potassium, &c., for a considerable period. Sections of the tumours presented an infiltration and deposit between the fibres of a gray plastic exudation; many of the muscular fibres were nearly colourless. This state may be followed either by a

* *Gazette médicale de Paris*, July 1856.

softening of the effused matter and its conversion into a kind of mucilaginous fluid, or may form an abscess, which, on slowly getting to a head, may burst, and leave an unhealthy ulcer with sloughy surface and foul discharge. Some of these enlargements, instead of suppurating, harden and become converted into cartilaginous or even bony structure.

A case is described in the *Gazette des Hôpitaux*, January 16, 1858, of a tumour involving nearly the whole length of the sterno-cleido-mastoideus muscle. When the muscle was contracted, the swelling was immovable, but in the relaxed state it could be moved on the deep plane of fibres; the skin, though not adherent, did not slide readily over it as natural, and there was a slight blush on it; there were dull pains in the part, which occurred at uncertain intervals, not more by night than by day; neither respiration nor deglutition was impeded. There were decided traces of old constitutional syphilis, as in most of the cases reported. The patient was about to undergo a course of the iodide of potassium.

Sometimes these swellings assume the form still more completely of defined tumours.

M. Robert* describes a case of a tumour which formed in the calf of the right leg as large as an egg, hard, unequal, and lobulated on the surface, somewhat movable, tender to the touch, but not painful, which was completely cured by the iodide of potassium. In *Path. Trans.* vol. vii. a very interesting account of a tumour is given by Mr. S. Jones; the tumour was removed by Mr. South from a patient in St. Thomas's Hospital, November 6, 1855. The patient had had syphilis eight years before, when he took mercury, but had no constitutional symptoms. He had received a blow on the left shoulder two years previously, and lost for some time the use of the arm; he, however, gradually recovered it after some months. He had pains in the shoulder, which were considered rheumatic, and were treated and cured by the iodide of potassium; nodes also presented themselves at several points, but they disappeared. Violent pains again came on in the shoulder, which were followed by a tumour in the infra-spinal region of the scapula; this increased rapidly in size; his general health suffered considerably. The tumour was well defined, moved only with the scapula, did not project much above the surface, and measured $6\frac{1}{2}$ inches in one direction, and 8 in another; it was removed with a large portion of the scapula. On examining it, it was found to be formed in the muscles, but principally in the infraspinatus, though nodules were found in many of the neighbouring muscles. The tumour was mostly hard and dense, slightly elastic, of a dead white colour, and of a homogeneous or slightly reticulated structure; the surrounding muscular fibres were directly continuous with its surface, and muscular fibres were present in great abundance in many parts of the tumour. Many of the fibres, examined by the microscope, had lost their striated character, and had become glistening, transparent, and structureless. The spaces between the fibres were occupied almost solely by cells. Mr. South has since informed me that the wound healed well, and there has been no sign of returning disease.

* *L'Union médicale*, No. 37, mars 29, 1839.

Simple contraction, or shortening of a muscle without apparent alteration in its structure or change from its normal condition, seems to be an occasional effect of the inflammation from syphilitic poison in the system, and is usually found in the muscles of the arm or fore-arm. M. Ricord has noticed this so long ago as 1842.*

M. Notta, in an interesting paper on Syphilitic Muscular Contractions,† gives three cases, the features of which were much the same; and in each the biceps was the seat of the contraction. There was no hardness or rigidity of the muscle when not in action; the pains were variable, being great on putting the muscle on the stretch, and mostly referred to its insertion. The contraction was slow, and gradually reached a certain point, causing fixed flexion of the elbow. The iodide of potassium, with minute doses of the proto-iodide, appears to have cured every case. The same may be said of the cases cited by Ricord‡ and others, in which there was a certain change of structure of the muscle, associated with contraction. As a general rule, mercury has done no good; in fact in many of the cases the disease appeared to increase while the patient was undergoing a course of mercury.

Muscular atrophy.—Muscular tissue is frequently subject to atrophy, which may consist of one or more of the following alterations:—

1. Simple atrophy.
2. Atrophy with granular degeneration.
3. Atrophy with fatty degeneration.
4. Atrophy with (the so-called) waxy degeneration.

In *simple atrophy* the degree of wasting of the muscular tissue varies considerably. Generally, the fibres, although paler and reduced in diameter, retain their anatomical characters. The transverse and longitudinal striæ are well marked, the sarcolemma preserves its usual delicate and transparent appearance, and the nuclei it contains are not increased in number. Such is the form of atrophy met with in chronic and exhausting diseases; in cerebral paralysis; after contusions, compressions, and affections of the joints. In many diseases, however, both acute and chronic, simple atrophy, or wasting of the muscular fibres, is accompanied, in a greater or less degree, by one or more of the degenerations above mentioned. Such is sometimes the case after acute fevers, particularly typhus

* *Gaz. des Hôpitaux*, p. 98.

† *Archives générales de Médecine*, sér. 4, vol. xxiv. p. 413.

‡ *Gaz. des Hôpitaux*, 1846, p. 1.

or typhoid; after alcoholism, lead-poisoning, rheumatism, &c. But there is another form of this malady, which is known by the name of *progressive muscular atrophy* (Craveilhier), *atrophie musculaire graisseuse progressive* (Duchenne), and *wasting palsy*. This curious disease differs in several respects from the atrophies above mentioned. It is always chronic, but of uncertain duration; is frequently hereditary; is capricious or irregular in its invasion; prone to spread from one part to another, or become general, and thus go on to a fatal termination. The affected muscles suffer different degrees of wasting, and assume a variety of aspects. Even in the same muscle, bundles in different stages of atrophy and degeneration may be found at the side of others that have retained their normal state. When the wasting is extreme in all the bundles, a long muscle may be reduced to a mere fibrous and cylindrical cord, or to a kind of tendon, and a flat muscle may be reduced in the same manner to a kind of membrane. In some instances the atrophy may be *simple*, that is, the muscular tissue may be wasted to a considerable degree without any granular or fatty degeneration; * but generally, one or both of these alterations of structure is found to exist to a greater or less extent. The muscle also changes and varies in colour according to the nature and degree of the atrophy. It is paler than natural; occasionally it is quite colourless, like the flesh of fish; or it may have a faint yellow or ochreous tint. Its consistence for the most part is increased in consequence of the increase of the interfibrillar connective tissue. When examined under the microscope, the affected muscles may be seen to have lost to a variable extent and degree, or even entirely, the appearance of transverse and longitudinal striation, while in a corresponding proportion the sarcous or muscular element is transformed into granules, which, in some instances, are too fine to be distinguished as separate particles. The granules are soluble in acetic acid.

Granular degeneration or disintegration of the muscular tissue may exist alone; but frequently it is accompanied by fatty degeneration, or may only form the first stage of the latter change.

Fatty degeneration.—This morbid process may make its appearance in the muscular tissue at once; or may follow, accompany, and altogether replace the granular change. Besides this

* Charcot, Hayem, Lockhart Clarke.

transformation into fatty *particles*, fat-cells in unusual, and sometimes in great numbers are found between the fibres, either collected into groups, or disposed in linear succession, like rows of pearls. These cells may multiply in proportion as the muscular tissue disappears, so that, when the fibres are reduced to mere filaments, there may be no loss of volume in the limb. An interesting case of this description is related by Mr. Hallett.* The degenerations seemed constantly to have commenced on the surfaces of the muscles, and extended inwards to their centres; so that many which appeared wholly converted into fat, exhibited, in their interior, muscular fibres in a more or less healthy condition.

Waxy or vitreous degeneration.—This structural change was first described by Zenker.† It is called by the French pathologists, *vitreous degeneration*.‡ According to Zenker, it is observable only in the voluntary muscles, and never attacks all the bundles of the same muscle. The essential change of structure consists of a transformation of the muscular tissue into a homogeneous, colourless, and glistening substance, in which the transverse and longitudinal striæ, together with the nuclei, have entirely disappeared. This kind of degeneration is more common after acute diseases, particularly after typhus and typhoid fevers, but occurs also in *progressive muscular atrophy*. Indeed, in this peculiar malady, all the three kinds of degeneration—the *granular*, the *fatty*, and the *vitreous*—may be seen, not only in the same patient, but in the same muscle.§

In a large majority of instances, *progressive muscular atrophy* first makes its appearance in one of the upper extremities, especially in the right limb. It begins commonly in the muscles of the hand, first in the thenar eminence, then in the hypothenar, and next in the interossei. When the interosseous muscles are considerably wasted, the hand assumes the appearance of a bird's claw—the *main en griffe*, as it has been termed by Duchenne. If the atrophy extends upwards, the flexors and extensors of the fingers, and sometimes the muscles at the back

* *Edinb. Med. and Surg. Journal*, April 1849.

† *Ueber die Veränderungen der willkürlichen Muskeln in Typhus abdominalis*, Leipzig, 4to. 1864.

‡ Cornil et Ranvier, *Histologie pathologique*.

§ Charcot et Joffroy, *Archives de Physiologie normale et pathologique*, 1869. No. 3, p. 363.

of the fore-arm, become involved. When the disease extends beyond these limits, it attacks the muscles of the arms and trunk; the biceps first, then the deltoid and the triceps, the pectorals, the latissimi dorsi, the rhomboidei, the extensors and flexors of the head, the sacro-lumbales, the abdominal muscles, the muscles of respiration and deglutition. Occasionally the depressor muscles of the jaw become involved. In some instances the atrophy is limited to the muscles of the fore-arm, and in others it begins in the muscles about the thorax, and makes considerable progress, while the arms remain unaffected. Sometimes it extends to the lower extremities, but rarely begins there.

The unequal and irregular wasting of the muscles produces in the trunk and limbs a variety of alterations in their shape and position, which are characteristic of the disease; for in ordinary atrophy succeeding exhausting diseases, the emaciation is uniform, as it affects nearly all the muscles of the part to the same extent.

The earliest symptom of progressive muscular atrophy is a loss of muscular power in the afflicted parts, especially after exercise or exposure to cold. With this weakness there is an awkwardness in the patient's movements, and a certain loss of muscular co-ordination, arising from the unequal or irregular wasting of the muscles, and the consequent change in their relative force or antagonism when employed in the performance of voluntary movements. Among the other early symptoms are cramps, twitches, and fibrillary tremors in the muscles. Generally the sensibility remains unimpaired, but occasionally there is numbness of the skin, or a certain degree of cutaneous anæsthesia; while, on the other hand, in about half the cases, more or less pain is experienced in the wasting muscles, or previous to their atrophy.

Pathology.—Cruveilhier, who was the first to investigate the morbid anatomy of progressive muscular atrophy, believed that atrophy of the motor nerves was the starting-point of the disease. This opinion was founded on eleven cases in which the motor nerve-roots were more or less wasted. But in the majority of instances in which post-mortem examinations were made, no appreciable alteration of the nerve-roots was discovered. It was therefore inferred that atrophy of the nerves cannot be the actual cause of that state of the muscles; and since no disease of the nervous centres had hitherto been

detected, it was further inferred and generally believed that progressive muscular atrophy is a disease originating in the muscles themselves, in consequence of impaired nutrition, resulting from a peculiar diathesis of an hereditary tendency. The more recent supporters of this view were Trousseau, Duchenne, Meryon, Roberts, Oppenheimer, Friedberg, Hasse, Friedreich, Cohn, and others. But in 1861, I discovered in the spinal cord removed from a well-marked case of progressive muscular atrophy, numerous lesions of the grey substance, consisting chiefly of areas of what I call granular and fluid disintegration.* In several other cases which I subsequently examined, the same kind of lesions were observed in company with similar alterations of some of the white columns, with dilatation of blood-vessels, or atrophy of the nerve-cells and of the anterior roots of the nerves.† Since my first publication on this subject, several German and French pathologists, by means of improved methods of observation, have obtained similar results.‡

Etiology.—Among the predisposing causes of progressive muscular atrophy, consanguinity, or hereditary influence, is universally acknowledged to hold the first rank. Dr. Roberts collected the history of ten families in which muscular atrophy prevailed, and of these, twenty-nine individuals were attacked. Aran relates that a sea-captain had lost two maternal uncles and a sister by this disease, and that another patient's two aunts had died from the same malady. Meryon's first cases were four boys who had six healthy sisters.§ In another family two boys were affected, while the two sisters escaped. The male sex is therefore much more prone to muscular atrophy than the female—in the proportion of about six to one. In nearly all the hereditary cases on record, the disease became generalized, and therefore tended to a fatal termination.

Among the chief exciting causes are excessive muscular exertion, cold and damp—especially when combined—and injuries or diseases of the spine. In those cases which are

* Beale's *Archives of Medicine*, 1861.

† *British and Foreign Med.-Chir. Rev.*, July 1862, and Oct. 1863. Beale's *Arch. Med.* No. 13; *Med.-Chir. Trans.* 1866 and 1867.

‡ See especially Hayem, *Archives de Physiol. normale et pathologique*, Nos. 2 and 3, 1869. Charcot et Joffroy. *Ibid.* 1869.

§ These interesting cases, with the microscopic appearances of the muscles, are recorded in vol. xxxvi. of the *Med.-Chir. Trans.*

attributable to the influence of cold and wet, the atrophy is generally preceded and accompanied by neuralgia or so-called rheumatic pains in the affected muscles, or in the course of the nerves leading to them. Syphilis, again, appears to be one of the assignable causes of the disease. To this form M. Rodet has given the name of *atrophie musculaire progressive syphilitique*.^{*} In some instances no particular cause can be clearly assigned, and these are the cases in which hereditary influence appears to come into operation.

Treatment.—This must of course depend, to a certain extent, on the causes to which the disorder may be reasonably traced. Removal from the influence of cold and damp, or avoidance of undue muscular exertion, is of primary importance. Warm and sulphur baths, especially those of Aix-la-Chapelle, have been particularly recommended. When there appears good ground for believing that the atrophy is attributable to syphilitic taint, iodide of potassium, or perhaps mercury, must be employed. In cases attributable to other causes, vegetable and mineral tonics, cod-liver oil, and phosphorus may be administered. Dr. Meryon speaks very highly of the long-continued use of arsenic. But of all remedies hitherto employed, galvanism is undoubtedly the most useful, when applied to the affected muscles. The benefit derived from it, however, is very often temporary. Remak strongly recommends the application of the constant galvanic current to the spinal column, particularly in the cervical region. The fact, as already stated, that in the advanced stages of progressive muscular atrophy, various lesions have been found in the spinal cord, would suggest the propriety of trying the effects of counter-irritants, particularly setons and blisters to the spine, in the early stages of the disease.

There are two other special forms of muscular atrophy, which are peculiar to the period of childhood, viz., the atrophy which follows infantile paralysis, and the degeneration of muscles with apparent hypertrophy.

1. The muscular atrophy of infantile paralysis is extremely interesting to the surgeon, in consequence of the deformities which it so frequently occasions. The period of childhood at which this disease makes its appearance varies from a few

^{*} *L'Union médicale*, No. 26, p. 403, 1859.

months to a few years after birth, more especially during the first dentition. The attack is generally sudden, and frequently preceded by a feverish state which may last a few hours or a few days, accompanied occasionally by convulsions, which are immediately followed by paralysis without loss of sensibility. The paralysis generally begins in the lower extremities, but rarely attacks the upper extremities alone. At first it is more or less general, but after a variable period it restricts itself to particular muscles, or groups of muscles, or to a particular member, and thus becomes localized. The muscles upon which it most frequently fixes are those at the anterior part of the leg—the extensors of the toes, and flexors of the foot; the extensors and supinators of the hand; the extensors of the leg, and muscles of the foot. Sometimes single muscles are affected, and most commonly, the extensor longus digitorum of the foot, the tibialis anticus, the deltoid, or the sterno-mastoid. After a time, varying generally from one to two months, but sometimes much longer, the paralysed muscles begin to waste, and may ultimately be reduced to mere fibrous bands. Nor is the atrophy confined to the muscles; it involves the bones, ligaments, and other parts.*

The paralysis and the atrophies by which it is succeeded combine to produce a variety of deformities and unnatural attitudes which call for the surgeon's skill, either in the application of mechanical apparatus, or in the performance of necessary operations. These deformities consist chiefly of *talipes equinus*, *equino-varus*, *equino-valgus*, *calcaneus*, or *calcaneo-valgus*, and *talipes varus*.†

The paralysis itself and the muscular atrophy to which it gives rise are not often fatal. The difficulty consists in restoring the muscles to their normal condition; but this, in many instances, may be accomplished. The remedies recommended by the most experienced practitioners consist of nuxvomica, strychnine, cod-liver oil, the preparations of bark and iron; sulphur and salt-water baths; blisters and counter-irritants along the spine; stimulating embrocations to the affected muscles, and especially the application of electricity.

* Laborde relates a case in which considerable atrophy of the deltoid muscle occurred in four *days* after the first appearance of the paralysis. *De la Paralysie (dite essentielle) de l'enfance*, p. 45.

† For the description and treatment of these deformities, see the following article, ORTHOPÆDIC SURGERY.

2. *Degeneration of muscles with apparent hypertrophy.*—This peculiar disease was first understood and diagnosed by Dr. Duchenne (of Boulogne) in 1858. Since then it has been recognised and investigated chiefly in Germany by Griesinger, Eulenburg, Cohnheim, Berind, Wernich, Oppolzer, Heller, and Seidel. It begins in childhood, like the malady just described, but often continues up to an advanced period of youth, when the patient is cut off by some intercurrent disease. Its course may be divided into three stages: a stage of partial and incomplete paralysis; a stage of apparent muscular hypertrophy; and a stage in which the paralysis becomes general, and the muscles waste.

The first stage begins with weakness of the lower extremities either before or after the period at which the child should be able to walk. In the former case, when the little patient attains the age of ten or twelve months, and attempts to walk or stand, it falls immediately, and continues unable to walk, even when assisted, for two or three years.

The second stage begins some months—or even as long as two years—after the muscular weakness, and is manifested by a progressive enlargement of the gastrocnemii, then of the glutei and lumbar muscles. This enlargement occurs sometimes in nearly all the muscles, but in general it is limited to a few. The enlarged muscles are firm and elastic, and become very hard during contraction. This condition may remain stationary for some years.

In the third stage the paralysis gradually increases and becomes more general. The patient is no longer able to stand upright; the upper extremities become affected; the enlarged muscles rapidly decrease in volume; and the limbs and trunk become atrophied *en masse*. In this state the patient may exist for a considerable time, but ultimately dies by intercurrent disease. Many of the children afflicted with this singular disorder have dull intellects, and are occasionally more or less idiotic.

Morbid anatomy.—The morbid anatomy of this disease has been investigated chiefly by Duchenne, in France, and by Eulenburg, Cohnheim, Griesinger, and others in Germany. Nothing abnormal could be discovered in either the nervous or vascular systems. Eulenburg and Cohnheim found the electro-muscular contractibility everywhere perfect. To the touch the muscles gave the sensation of a doughy and inelastic mass.

They were marked with stripes of a yellow or yellowish-white appearance. At certain points they could not be distinguished by the naked eye from the subcutaneous adipose tissue. There was also great hypertrophy of connective tissue between the muscular fibres, which were frequently much reduced in diameter, although they were not otherwise much altered. Duchenne and Ordoñez found the striæ on the fibres very much finer than usual, and semitransparent. The same appearance, together with an increase of connective tissue, and large collections of fat-cells, were also observed in one case by myself.*

Treatment.—During its first stage the disease is sometimes curable. Duchenne has recorded two such cases.† But in the second stage scarcely any hopes of recovery can be entertained. The treatment consists chiefly of local Faradization and shampooing.

Ossification of muscle.—The conversion of muscle into fat is truly a degeneration, as it is a change from a highly organised structure into an amorphous mass of adipocere. The same may be said of the so-called bony deposits in many soft parts, which are not true bone either in their structure or their chemical composition; while the ossific growth in muscle possesses all the qualities of true bone, and is merely the development of one organic structure within another, to which the term ‘degeneration’ would ill apply. Mr. Hawkins, in a clinical lecture to which I shall have again to refer, remarks that the ossific deposit in muscle is that of true bone with cancelli, compact shell, periosteum, and cartilage, displaying also under the microscope all the signs of true bone. Mr. Quekett showed Mr. Tatum some beautiful microscopical pre-

* Dr. Duchenne has invented an ingenious instrument which he calls the ‘emporte-pièce histologique,’ for removing small portions of muscle from the living subject. It is made by Charrière, of Paris, and consists of a steel cylindrical rod, divisible longitudinally into two parts; one of these is fixed to a handle by means of a screw, and terminates at the screw end in a small hollow cone, the base or lower border of which has a sharply-cutting edge. When closed, the two pieces together form a small cylindrical rod with a fine point. As soon as it is made in this state to penetrate the muscle, the hollow cone is opened by sliding down the other half of the rod, and encloses a small portion of the muscle, which it cuts and brings away as the instrument is withdrawn.

† *De la Paralyse musculaire pseudo-hypertrophique*, Paris, 1868; and *Archives gén. de Méd.* Janvier et seq. 1868.

parations, which prove the true bony nature of these deposits. Ossific growths may take place over a large extent of the voluntary muscles, or may be limited to one or two points. In the Museum of the College of Surgeons is the skeleton of a man in whom nearly all the muscles of the back had become ossified, large sheets and masses of bone occupying the places of the latissimus dorsi, spinalis, and rhomboid muscles, forming large bony sheets on the back and sides, while large stalactical growths of bone spring from the pelvis, ribs, and scapulæ. The following case is valuable from the circumstance of its progress having been watched from its commencement up to its very advanced state in 1862, when the account was published.

G. Brown, aged twenty-two, was originally admitted into St. George's Hospital under the care of Mr. Cæsar Hawkins in August, 1843,* with swellings in the dorsal and lumbar regions, some of them apparently bony. Their appearance was accompanied with severe rheumatic pains. All these disappeared under treatment. They reappeared, however, and then one was removed from between the trapezius and rhomboid muscles; it was intimately connected to both, fibres from both being inserted into it; one end of it was fixed to the spines of the sixth and seventh dorsal vertebrae, the other was smooth, playing on the end of the scapula. After this, for four years, fresh tumours were observed to form in different muscles of the trunk and neck, being at first soft, growing rapidly, then becoming hard, and, after a time, either disappearing altogether under treatment, or leaving a bony deposit behind. This new bone extended slowly towards either extremity of the muscle in ridges corresponding to its fibres. He was now lost sight of, but in June 1859 again presented himself at St. George's Hospital, with extensive ossification of the muscles together with several exostoses both on the spine and ribs. The greater part of the latissimus dorsi on either side, especially at the free edges, was ossified; large masses of bone filled up the hollows on either side of the vertebral spines from the sacrum to the occiput, soldering all the bones together into an inflexible column. The ribs were likewise immovable, partly from being ankylosed to the spine, and partly by the ossification of the muscles connecting them with the scapula and spine; so that respiration was entirely performed by the diaphragm. The trapezius, and, apparently, the deep muscles at the side of the neck, contained large deposits of bone; both scapulæ were immovably fixed to the ribs, principally by the ossification of the serratus magnus and rhomboid muscles. In front, both the great pectoral muscles, from their origins to their insertions, were almost entirely ossified, presenting ridges taking the course of the fibres, and forming large masses at the folds of the axilla. The sterno-hyoid and sterno-thyroid muscles were much ossified; and these, together with the recent appearance of a considerable swelling below the chin, had been accompanied with so much difficulty in deglutition as to alarm him; he therefore came to the hospital to see Mr. Cæsar Hawkins, under whose care he had before been. The fulness in the upper part of the throat was not hard, but very tender; it yielded to a second application of a blister in a few weeks, so that the genio- and mylo-hyoid muscles could be

* *Med. Gaz.* vol. xxxiv. 1844, p. 273.

distinctly felt almost entirely ossified. Preparations from this case are in the Museum of St. George's Hospital.

The cause of osseous growth in muscles is not easily explained. A tendency to increased bony deposit is not very uncommon, and shows itself in exostosis and extension of bony growth into the tendons inserted into the bones; but in ossific growth in muscle it is a distinct formation, and in no way, at first, connected with exostosis. It is of inflammatory origin, as the pain and swelling, and also the effects of remedies, would indicate. Mr. Abernethy mentions the case* of a lad in whom either an exostosis or bony growth in a muscle invariably followed a blow on the part. Mr. Hawkins alludes to an account of eighteen cases of bony growths in muscles among the recruits in the Prussian service; these were said to have been the result of inflammation in the deltoid and pectoral muscles. Inflammation of muscle is rare, and excess of bony deposit in the system is not very common; but when they both occur in the same individual, the exudative lymph in the former would seem to be a favourable nidus for ossific deposit. As regards the treatment, no local measures answered in the above case so well as blisters, under which, with the exhibition of colchicum internally, considerable diminution of the swellings and relief of the pain took place. The swellings completely disappeared after a course of the iodide of potassium, at first five, and then seven, grains thrice a day in sarsaparilla; but they returned again shortly after, while the patient was still taking the medicine. On the reappearance of the disease, mercury was given, two grains of calomel and a quarter of a grain of opium twice daily, which at the end of three weeks produced sore mouth; again, all the swellings were nearly removed, at first rapidly, then slowly; but a large mass of bone between the scapula and spine was removed, as stated, by operation. After this, from hæmorrhage and other causes, his health failed, and he was much reduced, and specifics were laid aside for some time. Numerous fresh tumours, having, however, formed, he, in a few months, began the phosphoric acid, first in half-drachm, and afterwards in drachm, doses, three times daily, which he continued from April 6 to May 21. The swellings greatly diminished under this treatment, and with the repeated application of blisters their recurrence seems to have been arrested. Thus the reme-

* *Surg. Lect.* vol. iii. p. 169.

dies appear to have been chosen with a view to the inflammatory nature of the complaint, and to have been most efficacious; yet so strong was the tendency to relapse, that the swellings formed again and again, even under the treatment that had caused them to disappear. They were, however, finally arrested, the blisters having been most conducive to that end.

TUMOURS IN MUSCLES.

Tumours of different kinds are occasionally found in muscle. Perhaps that which occurs most frequently is the fibrous tumour, of a cartilaginous hardness, and often growing to a considerable size.

A lad, aged fourteen, was under Mr. Tatum's care in St. George's Hospital in the summer of 1860, with a tumour as large as the double fist, at the back part of the left thigh, about its middle; it was extremely hard, and appeared to be a chondroid tumour growing from the bone, so closely did it seem to be attached to it; on relaxing the muscles, however, by bending the knee, it admitted of a certain movement on the femur. The tumour was removed, but not without difficulty, partly from its vicinity to the bone, which it seemed to grasp, and partly that the great sciatic nerve was imbedded in it, and was only freed by careful dissection. The tumour was found to have had its origin in the semimembranosus muscle, the lower part of which was healthy, but the part above the tumour was converted into a pale structure similar to the tumour, but less dense, and retaining the form of the muscle, with a slight remnant of fibrous appearance. The tumour was extremely dense, of a semitransparent, cartilaginous aspect. Some of the fibres of the muscle were spread over the tumour; others dipped into it, but were soon lost in its substance.

Shortly after this, a tumour of a similar character was removed from the deltoid muscle of a young man by Mr. Johnson; it was about the size of an egg, and surrounded on all sides by muscular fibres. Many of the fibres entered, and could be traced a considerable way into the dense fibro-cartilaginous mass.*

The recurring fibroid, although it does not originate in muscular structure, has a great tendency to be reproduced in it.

In two patients under the care of Mr. Hawkins in St. George's Hospital, each of whom had a tumour of this description in the breast, and in whom the tumours returned, and were removed several times, it was observed

* Mr. Curling gives an account of a fibrous tumour which he removed from the gastrocnemius muscle of a girl aged nine; its circumference was not very clearly defined from the muscle, so that its more prominent central part only was removed. See *Path. Trans.* vol. vi. p. 346. Mr. Birkett removed a tumour from the short head of the biceps flexor cruris, of a chondro-ostoid growth, $4\frac{1}{2}$ by 3 inches in size, of a greyish-pearl tint, and of cartilaginous structure; the centre was of bone. *Ibid.* vol. ix. p. 397.

that when the recurrence took place the pectoralis major was the part principally involved. A man came under Mr. Tatum's care, from whom a tumour of the above nature had been removed from the parotid region, and subsequently a recurring small one from over the masseter muscle; four months after which he became Mr. Tatum's patient, having a tumour about the size of a French walnut in the neighbourhood of the second cicatrix. On removing it, Mr. Tatum found that it had formed in the upper part of the masseter muscle, a few fibres of which only remained. A few months after this, he again came under Mr. Tatum's care, with two tumours the size of filberts a little above the site of the last, and which proved, on dissecting them out, to have had their seat in the temporal muscle. Mr. Tatum had a lady under his care from whose breast he twice removed a tumour of the above nature; the disease returned in the pectoral muscle, in which it made rapid progress. The event of this case is not recorded.

Cysts of various kinds are occasionally found in muscles. Some of these cysts contain hydatids. Such is the *trichina spiralis*, a bisexual and minute nematode worm which is reproduced viviparously by the female parent. The female *trichina* is about one-third longer than the male, and in the mature state contains in its uterus a variable number of ova, as well as free embryos in different stages of development. When the flesh of an animal containing spiral *trichinae* is eaten by another, the contents of the small intestines are found, after about twenty-four hours, to contain a multitude of these worms, which lie imbedded in the mucus or in the chyme. Soon after the embryos are born, they begin to migrate from the intestines in search of muscular tissue, upon which they feed and develop. Concerning the manner in which migration is effected, there is some difference of opinion. Most observers believe that the young *trichinae* pierce the walls of the intestines and other parts until they reach the muscles; while other observers, with Dr. Thudichum, contend that, after penetrating the mucous membrane of the intestines, they enter the blood-vessels and lymphatics, pierce the lymphatic glands, reach the heart with the venous blood, traverse the lungs, and are then distributed, by the arterial circulation, to all parts of the body. However, having reached the muscles, there they feed, and grow, and ultimately become encapsuled. Leuckart maintains that the young *trichina* always penetrates the sarcolemma, while other observers assert that it lives and grows either inside or outside that sheath. However this may be, so long as the worm remains outside, the muscular fibre is not permanently damaged, although it becomes somewhat granular, and loses the distinctness of its transverse striation. But if the parasite pierces

the sarcolemma, the fibre is permanently destroyed; the sarcous elements are disarranged, broken up, and transformed into granular masses, which constitute the food of the invader. As the trichina reaches its full growth and becomes fixed to one spot, the interstitial connective tissue and the sarcolemma around it, being irritated and inflamed, throw out an exudation, while the nuclei of both enlarge, divide, and rapidly multiply. The exudation, which appears to consist of fluid fibrine, soon after solidifies and forms a capsule in which the worm coils itself up. At the end of some weeks after infection, fine dark granules of carbonate of lime and magnesia are deposited in variable numbers within the capsule, and render it more or less opaque.

In man, trichiniasis is produced by the ingestion of imperfectly-cooked flesh of animals infested with trichinæ—particularly pigs.

The pathognomonic symptoms of trichiniasis are the following:—

Sudden swelling of the face, particularly the eyelids, after the patient has for some days felt prostrate and lost his appetite; fever, with quick pulse and copious perspirations, which have sometimes an offensive odour; painfulness and immobility of arms and legs; the muscles are swollen and contracted, and give great pain when set in motion or touched; the limbs are semiflexed; gastro-intestinal catarrh, with red and somewhat dry tongue; when the swelling of the face has subsided, the feet, legs, and thighs become cedematous, and soon after anasarca over the trunk ensues. There is no other disease in which this particular combination of symptoms occurs.*

Cysts containing a black tenacious matter are occasionally found in muscles; they probably are of the nature of hæmatoma occurring in other parts of the body, being merely unabsorbed extravasated blood, which has become darkened and inspissated by time. Warren describes a singular tumour somewhat of this nature. A tumour about the size of an egg was removed from the substance of the rectus femoris muscle of a woman; it was said to be of only five or six months' growth; it consisted of a hard dark-coloured muscular sub-

* For a recent and elaborate description of the nature and treatment of trichiniasis, see a paper by Dr. Thudichum in the *Seventh Report of the Medical Officer of the Privy Council*, 1864. Also a shorter paper by Dr. Althaus, in the *Medical Times and Gazette*, 1864.

stance, in the centre of which was a bony shell an inch in diameter, containing a dark-coloured fluid, which had deposited a black crust on the bony cysts.

Vascular tumours are not very frequently found in the substance of muscles. According to Mr. Campbell De Morgan,* they occur under three forms. 1. As tumours having the appearance of a varicose state of the veins, unconnected with the muscular tissue in which they lie, but yet not isolated by any well-defined covering of connective tissue. 2. As erectile tissue, forming in, and encroaching on, the muscular fibres, from which it is not separated by any defined boundary. 3. As erectile tissue, forming a defined tumour, having an investment of connective tissue not continuous with the muscular substance in which it is embedded.

The disease is most frequently congenital, but may come on later in life, after injury, or without any assignable cause. It is more commonly seated in the muscles of the lower extremities. The origin, mode of growth, and true structure have not yet been satisfactorily ascertained; but it either spreads through the muscular tissue or occurs in the form of isolated tumours. The muscular fibres on which it encroaches are compressed by the hypertrophied vascular and connective tissues, and their nutrition being impaired by the altered and thickened state of the capillaries, they degenerate to a greater or less extent, and become transformed for the most part into fat, while the connective tissue increases in quantity, and is in some places condensed into masses or bands, which, when they form at the circumference of the tumour, constitute its fibrous sheath. There appears, also, to be an increase in the quantity of yellow elastic tissue. The changes which occur in the vascular tissue itself are not well understood.

Sometimes the disease shows itself in a number of different places in the same subject, as in cases recorded by Cruveilhier; in one of these the hand and arm were covered with innumerable small tumours, varying in size from that of a small shot to that of a large bean. They were all composed of erectile tissue. It is generally allowed that vascular tumours are very prone to degenerate into cancer.

Scirrhus seldom originates in muscles, except in the tongue and substance of the lip. Warren describes a case of what he terms scirrhus of the muscle, which resembles more the account

* *British and Foreign Medical-Chirurgical Review*, 1864, p. 187.

given of the syphilitic tumour described as having been removed from the shoulder by Mr. South. Muscles readily become implicated in the disease occurring in neighbouring parts, and it is not unusual to find the muscles for a considerable distance around a scirrhus breast dotted with scirrhus tubercles. Melanosis must be very rare in muscles. Warren mentions a case occurring in the muscular structure between the base of the scapula and the spine; this had been removed, but a second tumour appeared in its place under the cicatrix; it was found, on operating on it, to be seated in the substance of the rhomboid and trapezius muscles; it was hard in structure, and the interior composed of black matter; six months after this, the disease reappeared, of a carcinomatous appearance, and proved fatal.

Encephaloid tumours no doubt originate in muscles, though they grow so rapidly, and involve every structure so indiscriminately, as makes it difficult, except in certain organs, to define their origin. Warren, speaking of this disease in muscles, describes three cases. These, however, are not clearly proved to have sprung from muscle, except the last, which had its seat in the lumbar muscles.

AFFECTIONS OF TENDONS.

Injuries of tendons.—It has been already observed that tendons are ruptured by the action of their muscles more readily than the muscles themselves; they may also be ruptured by direct force, as in dislocation, and they are often divided partially or entirely in wounds, and by subcutaneous sections. When a tendon is ruptured, or, what is nearly the same thing, divided by subcutaneous operation, the part which is attached to the muscle is drawn away from the opposite end for about an inch; this latter is but slightly retracted by the action of its antagonists. Blood is poured out between the ends, but much less than in rupture of muscles. The pain is said to be not very great; a considerable shock, however, is felt, as from a blow received on the part, accompanied by cramp of the muscle, and a perfect inability to use the limb; and in rupture of the tendo Achillis a feeling is described as if the heel were sinking into a hole in the floor. The tendons most frequently ruptured are the tendo Achillis, and the tendons of the rectus femoris and the triceps humeri. If the separation of the ends be not

too great either in rupture or subcutaneous division, they unite with much readiness, the new material soon acquiring great firmness. So rapidly is the process of repair carried on, especially in the early stage, that, according to Mr. Paget, in his sixth lecture at the College of Surgeons, a specimen six days after division (being the fourth occupied in the organism of the new structure) could bear the weight of twenty-five pounds; in another case the new material at the end of twenty-one days bore a weight of fifty-six pounds. The process of repair is briefly this, according to Mr. Paget (*loc. cit.*). For the first forty-eight hours inflammatory matter is poured out, and infiltrates the tissues between the ends; after this there ensues infiltration of a material of the character of the fibrine of the blood in a solid state, in which are enclosed the unabsorbed remains of the clot of extravasated blood, and the two ends of the divided tendon; this by degrees assumes a definite cord-like form; but even in five or six days it shows a nucleated structure, tending to the production of tendinous tissue. On the tenth day, the material becomes paler and less vascular, and assumes a distinctly filamentary form; and in about three weeks there is a perfect cord, of the nature of tendon. Mr. Paget further remarks, that in the further stage of the process the ends of the tendon swell and soften to the consistence of the effused matter, so that they merge one into the other, assuming thereby a closer adhesion. He also remarks, that the repair of the tendon does not depend on the non-division of its sheath, as has been supposed. Should the interval between the two ends of a divided tendon be great, a very imperfect bond of union will be established between them, as the end will become attached to the neighbouring tissues, and either a partial or entire loss of the use of the muscle will result. Where the integuments and surrounding parts are included in a division of a tendon, there is, as in muscle, a much greater retraction than where these parts remain entire; added to which, the material for the repair of the tendon being here common to all the other tissues included in the wound, they all become fused in a common cicatrix, so that under the most favourable circumstances a very imperfect union and limited use of the muscle ensue.

The treatment of ruptured tendon consists, as in rupture of muscle, in approximating the divided ends, and retaining them in that position until firm union is established. Close adapta-

tion cannot be hoped for, but still a perfect union with recovery of the action of the muscle usually takes place. The severed ends are brought closer and closer towards one another by the contraction of the new material as it becomes perfected, and the remaining deficiency is fully compensated for by the accommodating nature of the muscle. If the tendon of the triceps be torn, all that is required is a bandage from above downward, with a splint in front of the arm to keep it extended: and as the union of tendon is rapid, passive motion may be employed early. In rupture of the tendon of the quadriceps extensor cruris, the same treatment nearly may be adopted as for a fractured patella. Where the tendo Achillis is torn across, the treatment consists in keeping the foot extended on the leg, and the leg bent on the thigh; a position favourable to the relaxation of the gastrocnemii muscles. For this purpose a belt is placed round the thigh a little above the knee, the back of which is attached to the heel of a slipper by means of a belt or bar. Before applying the instrument, the calf of the leg should be bandaged from above downward, care being taken not to approach too near the seat of rupture, for a great displacement and permanent defect would result from the ends of the tendon being pressed towards the bones of the leg; somewhat of a similar inconvenience may occur from a too considerable or a too long-continued tilting up the heel. Desault, to avoid the displacement of the tendon by his bandage, which, like Petit's, extended over the whole limb, recommends compresses at the sides of the tendon. John Hunter, who himself had a rupture of the tendo Achillis, recommends that, as so little inconvenience attends a small separation of the tendon, compared to the great inconvenience and difficulties attending the treatment by bandages and straps, the parts should be allowed to remain in their natural position. He is, however, disposed to adopt a medium between the two, and suggests that the heel should be elevated during walking, by raising the heel of the shoe; that a bandage should be kept steadily applied to the calf of the leg, to guard against involuntary actions of the muscles; and that at night the usual slipper and strap might be applied. When the integuments and surrounding parts are included in the division of a tendon, the edges of the wound may be brought together by adhesive plaster, or perhaps by sutures. The mode of bringing the divided ends of the tendon together by means of sutures can scarcely be recommended, as they produce irritation, and keep

the wound open. Bandages are not well borne; rest, therefore, with position, must mostly be trusted to for the cure.

Inflammation of tendons.—Tendons, together with their sheaths, both fibrous and synovial, are not unfrequently inflamed. Independently of gout and rheumatism, the most frequent cause is a sprain or wrench in the neighbourhood of a joint. These injuries are occasionally productive of long-continued wearing pains, assuming much of a rheumatic character, and yield, often slowly and unwillingly, to the remedies, both local and general, employed in rheumatism. Sometimes these sprains are followed by inflammation, with great effusion into the sheath and surrounding cellular tissue (especially in the region of the foot and ankle), which, either rapidly in an acute form, or slowly in a chronic form, may extend to the ligaments and periosteum, destroying the joints, and producing caries of the bone.

Under the name of ‘*ténosynite crépitante*,’ the French describe a slight degree of inflammation of the sheaths and investments of the muscles and tendons: it follows long-continued and fatiguing muscular exertion, and for the most part occurs in the muscles of the fore-arm. I have observed it mostly in the extensor muscles of the thumb as they pass over the radius; it is usually accompanied by considerable pains extending up and down the limb, and a well marked crepitating or creaking feeling can be felt by grasping the part while the muscles are in action. The treatment consists in complete rest, and stimulating or even vesicating applications. In one of the forms of whitlow, *paronychia tendinosa* of Abernethy,* the tendons and their sheaths in the finger and hand are the seat of a severe and often most destructive inflammation, which, though often confined to one finger, not unfrequently extends to the hand and arm, attacking not only the tendons and softer parts, but exposing the bones and disorganising the joints. It arises from the same causes as the other forms of paronychia, slight wounds, pricks, with or without inoculation of irritating or poisonous matter, and often without any evident cause, though doubtless, depending much on the state of the general health. It begins with severe and throbbing pain on the palmar face of a finger, which extends along the arm, often to the shoulder: it is

* Lect. xxviii. *Lancet*, April 29, 1825.

accompanied by redness and swelling, with great hardness and tension: if not checked, the inflammation proceeds quickly along the front of the finger, and is soon followed by suppuration in the sheath; this at first is in small quantity, and, in consequence of the great hardness and swelling of the part, cannot be detected by the touch; if no relief be afforded, the suppuration quickly proceeds along the sheath, the inflammation and pain are aggravated by the density and unyielding nature of the parts, and are accompanied by much constitutional disturbance; abscesses burst externally from time to time as the disease extends along the sheath, from which fungous granulations spring, the tendon in a sloughy state lying at the bottom. With proper treatment, and in a favourable state of the general health, the progress may be arrested with a greater or less amount of destruction of the parts attacked, and a proportionate deformity. In certain unhealthy states of the system, however, in which the diffuse or erysipelatous form of inflammation prevails, the inflammation and suppuration extend into the palm of the hand behind the palmar fascia, and to the rest of the fingers. The whole hand now presents a highly inflamed appearance, of an erysipelatous nature, with great swelling and tension; nor does the mischief end here, but, passing under the transverse ligament of the wrist, ascends into the fore-arm, forming large diffuse abscesses amongst its tendons and muscles; and in the worst cases not only the joints of the finger, but those of the carpus and wrist are destroyed, and the bones denuded and necrosed. The health during this time suffers severely from irritative fever, with gradual prostration of the bodily powers.

Treatment.—In the very early stage the inflammation may often be arrested by leeches, followed by hot fomentations to soften and relax the hard and unyielding tissues. The hand should be elevated, and an active purgative, with other antiphlogistic measures, prescribed; if relief do not soon follow, but, on the contrary, the continuance of pain and throbbing with increased hardness indicate the extension of the inflammation, if not the formation of pus, no further time must be lost; a free incision must be made along the centre of the finger, and though there may be but very little or no pus in the sheath, yet the division of the tensely strangulated structure, and the escape of blood and serum, afford the greatest relief. By these means all mischief may be arrested, and the finger perfectly restored. On the other hand, the inflammation may proceed along the

sheath in spite of the most ready treatment ; suppuration may have extended under the palmar fascia ; further incisions must then be made ; and it will now be found proper to support the powers of the system by a generous diet, stimuli, and tonics. In these cases the tendon will slough, and one or more of the joints will be ankylosed, with such disfiguration as may at a future time require amputation ; for a stiff and distorted finger, in almost any condition of life, is very inconvenient as well as unsightly. In the more chronic states, where, notwithstanding free openings having been made in the palm, abscesses burrow about the hand, I have found the best results from pressure with pads of lint soaked in pure liquor plumbi, and a bandage, the powers being supported with tonics, good diet, and stimuli. Where the suppuration extends to the arm, the case is more serious ; and if, from the state of the constitution before alluded to, it proceeds to the indiscriminate destruction of the joints, nothing but amputation remains, and even that may not save life.

Mr. Tatum has amputated the fore-arm twice for this disease : the first case was in a gardener, a patient at St. George's Hospital. He seemed healthy and strong, but the diffuse suppuration extended rapidly along the sheaths to the hand and arm, destroying the joints of the hand and wrist, in spite of every endeavour to arrest the disease ; and though amputation was performed before the powers were very much prostrated, it was only by constant attention and active treatment that after a long time the man recovered. The other case was that of a gentleman, aged fifty-five, whom Mr. Tatum attended with the late Mr. B. Cooper and Mr. H. Phillips : he was of a bad habit of body, pale and flabby, with a weak pulse ; the suppuration, beginning in the little finger, spread with surprising rapidity along the sheath, quickly involved the other fingers, then the hand and fore-arm, destroying the joints in its course, in spite of free incisions and whatever could be devised in the way of support. Nothing produced the slightest check to the progress of the inflammation, nor any reaction of the system ; it was therefore agreed that the arm should be amputated. Mr. Tatum performed the operation unusually high up in the fore-arm, with a view to cut through sound parts ; but even at this height the knife passed through the extremity of an abscess. No reaction took place after the operation ; the stump soon assumed a flabby, half-sloughy state ; and after some days the patient sank.

It has been already remarked that tendons, as well as muscles, are the seat of syphilitic enlargements. In one of the cases recorded by Mr. Tatum, the tendinous origin of the sterno-cleido-mastoideus was much thickened. M. Bouisson (*loc. cit.*), describing these swellings, remarks that they are formed by deposit between the fibres, as in muscles. He also relates a case of strabismus from a syphilitic tumour occurring

in the tendon of one of the muscles of the eye. M. Lisfranc* speaks of certain node-like swellings on the surfaces of tendons, which he calls 'nodosités blanches des tendons.' Syphilitic enlargements of tendons do not, as in muscles, readily yield to the internal use of the iodide of potassium; they require an active local treatment as well, such as iodide and mercurial ointment, or blisters kept open with mercurial ointment. Swellings of the tendo Achillis occasionally occur without a syphilitic origin. Mr. Tatum has found them in persons who have taken long and fatiguing walks, not having been accustomed to much exertion. These swellings sometimes occur as a simple rounded enlargement in the tendon, and sometimes as an irregular thickening; they are tender when handled, and are sufficiently painful in walking to make the patient limp. These tumours are often troublesome to cure, as they do not readily get well without rest, and the pain and inconvenience are not usually sufficient to induce the patient to lie up; in order, however, to cure them, it will generally be found necessary for the patient to lie up, or at all events to avoid using the part, and to apply the local means recommended in syphilitic tumours, as blisters kept open with mercurial ointment, or the emplastrum ammoniaci cum hydrargyro, &c.

Tumours of tendons.—Malignant tumours do not often spring from tendon; it offers, on the contrary, like other fibrous structures, a lengthened resistance to their progress. Warren gives the following account of a malignant tumour growing in the substance of tendon. A round and prominent tumour appeared above the patella three inches in extent, without much pain or sensibility, but causing lameness; it had been growing six months. On cutting down, the fibres of the rectus tendon, which were stretched over the tumour, were separated, exposing a white fungous growth firmer than the ordinary fungous tumour, but breaking in pieces when handled. On removal, it was found to be mixed up with fasciculi of tendinous fibres. It showed no disposition to bleed. This tumour returned after the healing of the wound, and was again removed, when it presented a more decidedly fungoid character, with fewer tendinous fibres. The case terminated fatally, with the formation of tumours within the abdomen. Fibrous tumours occasionally arise in tendinous structure, as in fasciæ, and other parts of a

* *Gazette des Hôpitaux*, No. 1842.

fibrous nature. Small cartilaginous enlargements are often found in the course of tendons, especially those of the hand and foot; they do not grow to a large size, and seldom produce any inconvenience. Small growths, described as *tæniophytes* by Albers,* are sometimes found growing on the surface of tendons near their junction with their muscles; they vary in size from a pin's head to a cherry; they are at first altogether cartilaginous, but as they increase in size calcareous matter is deposited in them, as in the development of bone.

AFFECTIONS OF BURSAE MUCOSÆ.

The closed synovial bags called *bursæ mucosæ* are of two kinds; those situated in the subcutaneous cellular tissue, and those connected with tendons. The subcutaneous bursa is formed of cellular membrane that has been exposed to friction and pressure, by which its cells are obliterated and a single cavity formed; it retains, in part, the form of its cellular origin, for even after great distension the interior often presents a sacculated or multilocular appearance. Like cellular membrane it has much of the character of serous membrane, in its ordinary state exhaling a fluid little denser than serum, but assuming, after a time, much of the nature of synovia. The subcutaneous *bursæ* are numerous,† and are either normal or adventitious. The normal occur mostly between the skin and some bony prominence. The adventitious *bursæ* are formed below corns, bunions, or other accidental callosities, as those arising in talipes on the sides or back of the feet. These sacs are liable to become enlarged from various causes, mostly local, as pressure, friction, or blows, though occasionally constitutional. The bursa in front of the patella is most frequently the seat of enlargement, forming a tumour familiarly known as *the housemaid's knee*. The contents of these enlarged cysts vary much; at first they are distended with a fluid little more dense than serum, gradually acquiring more and more the nature of synovia; it is often mixed with blood, either recent or in a thick grumous state; sometimes there is a dark-brownish adhesive fluid containing cholesterine; occasionally, after long-continued pressure, fibrinous matter is deposited within the sac, something after the manner of an aneurism, which gradually fills up the cavity, forming a tumour of a

* Vidal, *Pathol. extern.* vol. ii. p. 763.

† Ibid vol. i. p. 595.

dense fibrous structure; sometimes it is solid throughout; more frequently there is a central cavity containing a gelatinous fluid; sometimes the fluid in an enlarged bursa contains numerous bodies, resembling melon-seeds or parboiled rice; these are of a dense, fibrinous nature, and appear to be either the result of broken-up deposit, the portions becoming round and smooth by motion and attrition, or productions from the inner surface of the fibrous deposit, which from the effects of motion and friction become first pedunculated, and then, being detached, fall loose into the fluid of the sac, much in the same way as occurs in the formation of loose cartilages in joints. Inflammation, terminating often in suppuration, sometimes takes place in bursæ mucosæ; we see it occurring in a previously healthy state of the part, after a severe blow or a wound, especially in the bursa over the olecranon; the inflammation runs very high, and is not confined to the sac itself, but, in a diffuse form, extends often over the whole arm, with much swelling, redness, and tension; the pain is great and the constitutional disturbance considerable, and in old people there is sometimes much danger. Pus forms rapidly, not only in the sac but also in the cellular membrane, if not relieved. Enlarged bursæ of the patella are frequently attacked by inflammation and suppuration, and usually there is extensive inflammation of the surrounding cellular structure; and sometimes such large collections of pus are found in the neighbourhood of the sac, as led Sir B. Brodie to consider that the suppurating bursa occasionally gave way, and allowed its contents to escape into the cellular membrane. The readiness with which the neighbouring cellular membrane is involved in the inflammation of subcutaneous bursæ, is probably due as much to the sameness of their nature as to the continuity of their tissue. Troublesome and burrowing ulcers sometimes remain after these abscesses, and sometimes from undue pressure and neglect of a hardened cyst. These ulcerations are singularly obstinate, sometimes with considerable fungous growths, the skin around being dark and unhealthy, with deep burrowings under the integuments about the knee, and a foul and offensive discharge.

Treatment.—Whatever treatment may be adopted, it should be accompanied by complete rest. When the bursa over the patella is affected, a well-fitting ham-splint may be applied, and all motions of the knee-joint prevented. Simple enlargement, if recent, will often subside under rest and a slightly

stimulating lotion, such as ammoniæ hydrochlorat. ℥j., aquæ ℥v., aceti ℥j. M. Some merely transfix the bursa with a needle, and leave it to itself. If the enlargement has been of some duration, with thickening, more decided measures will be required. Some surgeons evacuate the contents by puncture, and follow it by pressure with a pad and strapping; the sac is likely, however, to fill again, and will require repeated punctures. Counter-irritants often effect a cure, such as the emplastrum ammoniaci cum hydrargyro, or a blister over the part. The iodine ointment or the tincture of iodine applied to the skin over the tumour, may in some cases succeed, especially where the contents have been previously evacuated. Mr. Key* recommends a seton, composed of a few threads of silk, to be passed through the cyst; suppuration is thus set up, and the pus escapes on moving the threads from time to time; compression is also employed by means of a pad and adhesive plaster, the openings being left free. By these means the discharge gradually diminishes, and, partly by contraction and partly by granulation, the cavity becomes obliterated. The French surgeons often treat these cases with iodine injections, like hydrocele. When there is much solid deposit in the sac, Mr. Key still finds the treatment by seton the most effectual; for, considering that the induration is kept up by the irritation of the cavity, the seton, by producing inflammation and suppuration, would cause its obliteration, and the absorbents would remove the indurated walls. When the tumour has become almost or quite a solid, gristly mass, there is no remedy but dissecting it out, which can readily be done without any bad consequences. Where the tumour is very large, and overlaps the patella, care should be taken not to wound the aponeurotic covering of the joint.

In acute inflammation of the bursæ, both local and general antiphlogistic measures are required; but where there is diffuse inflammation around, of an erysipelatous tendency, much benefit is derived from the sesquichloride of iron lotion,† with general support. If suppuration has taken place in the sac, it may either be laid open with a free incision, or a seton may be passed through it; the former would be preferable where there is much surrounding inflammation, as it not only gives free exit to the matter, but diminishes tension, relieves the vessels

* *Guy's Hosp. Rep.* vol. i. p. 415.

† Tinct. ferri sesquichlor. ℥j., aquæ destillat. ℥viii.

of blood and the cellular membrane of the effused serum, and often prevents it from running into suppuration. If pus have already formed in the cellular tissue, it will probably be necessary to make one or more incisions for its escape, in as depending a position as possible, and the system will require general support and stimuli.*

The bursæ of tendons have more the character of synovial membranes than the subcutaneous bursæ, and are either simple bags containing a lubricating fluid, placed between tendons and prominences of bones, as that between the ligamentum patellæ and the tubercle of the tibia, or complicated with numerous processes and elongations, as in the synovial sheaths of the flexor tendons of the hand and wrist. These, like the subcutaneous bursæ, are liable to enlargement, and often attain a considerable size; but, from their deeper situations, they are less exposed to injuries from without, and consequently do not so frequently inflame and suppurate. The bursa between the ligamentum patellæ and tibia sometimes enlarges and forms a tumour, which, by filling up the depression on each side of the ligament, presents the appearance at first of synovitis of the knee-joint; but the absence of swelling above and around the patella renders the diagnosis easy. Distension of the bursa above the knee usually accompanies synovitis, because this bursa almost always communicates with the joint; this, however, is not always the case, and Mr. Tatum has seen a large bursal tumour under the vasti, the joint being quite healthy. One of the bursæ of the hamstring muscles (usually that of the biceps) occasionally enlarges, and appears in the ham as a pulsating tumour, often of considerable size; it is, however, too little like an aneurism to be mistaken for one by a careful observer. The same may be said of the bursa of the subscapularis, and other bursæ about the shoulder-joint, which sometimes form tumours in the axilla, occasionally pulsating from their vicinity to the artery. The bursa between the psoas and iliacus internus and the capsule of the hip-joint sometimes forms a tumour, which from its situation may be mistaken either for an inguinal aneurism or for a psoas abscess; the extrinsic character of the pulsation and the absence of all other aneurismal symptoms in the one case, and the want of spinal symptoms and of fluctuation above Poupart's ligament in the other, assist in forming a right diagnosis. This bursa occa-

* For bunion see SURGICAL AFFECTIONS OF THE SKIN.

sionally communicates with the synovial membrane of the joint, and when inflammation occurs in the former, the latter will most likely be involved in it, and serious mischief may follow. The bursa between the glutæus maximus and tuber ischii, that between the tendon of the glutæus medius and the trochanter, and that between the latissimus dorsi and the angle of the scapula, from their exposure to pressure and other sources of irritation and inflammation, are not only liable to inflame, but even to suppurate. When, from frequently recurring pressure in sitting, the already enlarged ischio-gluteal bursa inflames and suppurates, it increases in size, becomes painful, and renders sitting on the part impossible, and even motion distressing; lying deep under the mass of muscle, its fluctuation is obscure, and the suppuration is usually slow in coming to the surface, and after it is evacuated, it often leaves a sinus obstinate and slow to heal, from its depth and the movements of the muscle. The same may be said in most respects of the bursa over the trochanter. The bursa at the angle of the scapula often acquires a great size, and when it suppurates, much constitutional disturbance is often set up. Too much caution cannot be taken in opening these bursæ, whether in their simply enlarged state or in the suppurating stage, as an alarming and even fatal train of symptoms sometimes follows the operation.*

The palmar bursal tumour is perhaps the most obstinate of any; forming a swelling under the palmar fascia, it extends under the transverse ligament and ascends into the fore-arm, presenting a double tumour, the contracted part corresponding with the transverse ligament. The fingers are more or less drawn into the palm of the hand, and cannot be straightened. The fluctuation is readily felt by alternate pressure above and below, and when, which is often the case, the melon-seed bodies are present, a peculiar creaking or grating sensation is communicated to the touch. These bodies are often extremely numerous; Dupuytren believed them to be hydatids, and described their appearance minutely.† These tumours, after slight attacks of inflammation, often cease to fluctuate, and become filled with solid, unorganised fibrine; and when inflammation, followed by suppuration, comes on, which it usually does from using the hand in this state, large masses of the coagulated substance

* On the diagnosis between diseases of the bursæ and of the joints, see DISEASES OF THE JOINTS.

† *Leçons orales*, ed. 1839, vol. ii. pp. 140 et seq.

may be squeezed out through the opening made to let out the pus; this has been followed by the gradual subsidence of the abscess, and the perfect restoration of the use of the hand. Sometimes, however, the case takes an unfavourable course; diffuse erysipelatous inflammation is set up instead of that of a more plastic nature, and a fatal result will occasionally ensue.

A patient was admitted under Mr. Tatum's care into St. George's Hospital with disease of this bursa. He was a publican, about fifty years of age, of a stout, flabby appearance, with failing pulse; the bursa, which had suppurated, had been opened above and below the wrist, and was discharging large quantities of pus mixed with the rice-like bodies in great numbers; the hand was enormously swelled, and the whole arm, extending above the elbow, enlarged, tense, and of a deep-red colour. The case in many respects resembled that of diffuse thecitis formerly described, and, like it, proved fatal, in spite of every means to support the system that Mr. Tatum could employ.

A modification of the bursa is found connected with the extensor tendons of the fingers and toes; these are termed ganglions; their cavities do not appear to communicate with the sheaths of the tendons, but are formed in the dense tissue investing the sheaths or the capsule of the joint.* They form small round, movable tumours, rarely larger than a filbert, mostly at the back of the wrist; they are seldom painful, but the patient usually complains of a sense of weakness in the joint. They are found less frequently on the dorsum of the foot; here they present a more compressed form, and are less movable than in the hand. Mr. Tatum has seen them on the outer part of the dorsum of the foot more than two inches in diameter, broad and flattened. These cysts contain almost constantly a firm gelatinous substance, nearly as dense as the crystalline lens of the eye. Ganglia do not, like subcutaneous bursæ, arise from pressure; they sometimes follow a sprain, but usually appear without evident cause; they are generally slow in their growth, but now and then appear quite suddenly.

Treatment of enlarged bursæ of tendons.—These bursæ sometimes enlarge rapidly, under which circumstance they subside quickly by rest and evaporating lotions. The more common and chronic form of enlargement requires a more active mode of treatment. Sometimes a blister alone may be sufficient to cause their disappearance; this will be more effectual if the cyst has been previously emptied by puncture; and it may be

* See Boyer, *Trait. des Mal. Chir.* vol. xi.

advisable to keep the blister open. Compression after evacuation of the cyst may succeed in some cases. If they prove obstinate, they may be treated like a hydrocele, by injection of equal parts of tincture of iodine and water; this, however, should not be done in those bursæ which occasionally communicate with joints, nor perhaps in the bursa between the latissimus dorsi and scapula, for reasons already given. A seton often answers well, as in subcutaneous bursæ. The palmar bursa, when enlarged, as well as that at the angle of the scapula, requires some consideration as regards the health, powers, and condition of the patient before active measures are adopted for curing it; for it must be remembered that these measures effect a cure by setting up active inflammation and suppuration; and it has been already seen how prone the inflammation is to take on a diffuse and most unfavourable form, especially where the bursæ are extensive. Where the tumour is not of long standing, it may often be much diminished, if not cured, by puncturing it, which may be followed by either compression or blisters. In a patient under Mr. Tatum's care with inflamed thecal bursa (a nurse in the hospital), blisters were kept open for some time; after two or three successive punctures the tumours were much diminished and felt solid, the cyst containing evidently coagulated fibrine alone; she was now enabled to use the hand and attend to her duties. At the end of a few months, however, the hand became painful and inflamed, and fluctuation was perceptible both above and below the transverse ligament; an opening was made in each part, and a small quantity of pus escaped, mixed with fragments of coagulated fibrine. Seeing this, Mr. Tatum enlarged the opening and squeezed out a large quantity of very firm straw-coloured coagulum; the cyst being emptied, a poultice was applied, and a generous diet ordered. Considerable discharge took place for some days, but gradually diminished; the wounds healed, and so complete was the recovery, that but for the marks of the incisions, no signs of previous disease existed. It has been recommended to lay open the entire sac, dividing the transverse ligament, and dressing the wound to the bottom with lint. This treatment one would hardly recommend, though where the rice-like bodies exist, simple punctures will not give exit to them, and incisions must be made for the purpose. In some cases both the seton and iodine injections may be employed, but with extreme caution. The ganglion may be

treated in various ways ; it is apt, however, to return. If the walls are not very dense, the sac may be ruptured by firmly compressing it with the two thumbs, or it may be divided subcutaneously with a tenotomy knife, or punctured with a grooved needle, and the crystalline contents squeezed out. Whichever plan is adopted, the swelling will probably return, unless further means be employed, such as firm compression with a small solid body tightly bandaged over the part; or a blister may be applied over the part with a good effect. Boyer (*loc. cit.*) has described a case of very extensive ganglion connected with the extensor tendons of the fingers, which he dissected out and dressed to the bottom with lint, having previously failed in the treatment by seton and compression. The result of the operation was very favourable. These cysts, however, cannot be entirely removed by operation ; the attached parts cannot be dissected from the tendon or ligament ; so that they will return unless the wound be kept open to the last.

T. TATUM, 1862.

J. LOCKHART CLARKE, 1870.

ORTHOPÆDIC SURGERY.

SINCE the labours of Stromeyer, published in 1831, an important class of affections, denominated contractures and deformities, has deservedly much engaged the attention of the surgeon. Scarpa in 1803, Jörg, 1806, Rudolphi, 1823, Delpech, 1825, Dupuytren, and others, had, without much immediate fruit, endeavoured to remove the obscurity in which this class of affections was involved. Their inquiries happily served to direct the researches of Stromeyer into a proper direction. The term orthopædy has become generally used to signify the treatment of this class of affections.

The pathological nature of the affections relievable by surgical orthopædic treatment, often by division of tendons (tenotomy), is various. They consist mainly of alterations, in form and movement, of the articulations, especially of those belonging to the lower and upper extremities. These spring

1. From accidental injuries of articulations; undue pressure and strain; inflammation of joints or contiguous parts, particularly those succeeded by suppuration and its consequences.

2. From derangement of the cerebro-spinal system, leading to paralysis or spasm and contraction.

3. From congenital influences, the varieties of club-foot, for example; malformations.

Orthopædic surgery comprehends, therefore, a multitude of abnormal forms of the muscular, ligamentous, and osseous systems, of which some are treated elsewhere in this work. On the pathology of deformities arising from diseases of the joints, the reader is referred to the essay on those diseases. Rachitic deformities are treated of in the essay on the SURGERY OF CHILDHOOD; spinal curvatures, in that on DISEASES OF THE JOINTS; strabismus, at p. 249; malformations, with the SURGERY OF CHILDHOOD; burn-contractures, under PLASTIC SURGERY. The affections which we have here to consider are

principally those which can be remedied by division of tendons, by mechanical extension, or by both of these means combined.

Before proceeding with the description of the individual contractures relievable by tenotomy, it will be well to consider the circumstances which give rise to contraction and deformity, and to inquire into the condition of the muscles and tendons which renders their division necessary. It is now a well-understood law of pathology, that if any part of the body, into the composition of which muscles enter, be maintained in a state of absolute repose, or be habitually kept in one position, so that the origins and insertions of particular muscles are constantly approximated, whilst the points of origin and insertion of other muscles are consequently proportionately separated, a shortened, contracted condition of the first set of muscles, and an elongated, weakened state of the second set of muscles, are produced. This is illustrated by what occurs during a simple fracture or other injury of an extremity. If the elbow, for example, be for any reason retained a few weeks in the bent position, the muscles on the flexed side of the member become stiff and contracted, and are only gradually restored to their natural mobility by active and passive exercises and use, whilst the stretched-out and weakened extensor muscles recover but slowly their full power of extending the implicated articulation. The state of things just described is aggravated when inflammation, exudation, suppuration, loss of cutaneous or more deeply-situated tissues, and consequent adhesions and cicatrices, interpose pain and physical obstruction to the restoration of complete mobility. The greater duration of the disorder increases the probability that persevering or active remedial means will be required to obviate the shortening of one set of structures and the elongation and weakening of the opposite set. This shortening and contraction occur more rapidly during the earlier years of life.

The influence of paralysis in producing contracture varies according to the nature and extent of the seizure. A single muscle, as the sterno-cleido-mastoideus, the tibialis anticus, or the external rectus of the eye, may be more or less completely paralysed; and the antagonist sterno-mastoid, the gastrocnemius, the peronei, or the adductor oculi, may become contracted. Or several muscles habitually associated in their actions may lose their power of voluntary contraction, as the extensors of the wrist and fingers; and the opposing muscles

also habitually associated in their actions, viz. the flexors of the wrist and fingers, become relatively shortened.

The demonstration of the precise amount and nature of the changes which occur in the central and peripheral parts of the nervous system, as far as apparent cause and morbid anatomy can teach us, and the determination of what particular functions of the muscles are primarily disturbed, belong to the special pathology of the nervous system, which need not here be entered upon. Few paralyses occur without some degree of contraction ensuing as a consequence, either directly from the impairment of the balance of muscular activity, or from forced repose or maintenance of the part in a particular position.

The induction by abrupt spasm of a more or less rigid, more or less permanently contracted state of a part, is obvious and easily intelligible; but the spasm which produces many persistent deformities is not always of that active, prompt, or tonic kind which is illustrated by certain cases of non-congenital wry-neck and club-foot, but is usually more slow and progressive, as seen in many children's cases of foot-deformity. The contraction in congenital club-foot and in the majority of congenital distortions can, we believe, be assigned only to a preternaturally excitable or spasmodic condition of the muscular fibres of the shortened muscles. In many cases, even when the shortened muscle has been set free by tenotomy, the morbidly excitable retractile disposition of the muscle often shows itself again after reunion of the divided part, and the cessation of employment of the mechanical or other means by which the affected muscle had been kept in an elongated state.

This contraction of certain muscles in congenital club-foot, which, for want of any other appropriate term, is designated spasmodic, is therefore very different from the active powerful retraction which occurs in certain comparatively sudden non-congenital cases, and in which the will of the individual is powerless to effect an improved condition of the limb. In congenital club-foot, and in analogous gradual non-congenital talipes in which paralysis does not exist, if the child is old enough to exercise volition, the affected muscles are to a certain extent subservient to the will, although volition is incapable of willing entire relaxation of the contracted muscles. Thus the contraction in this non-congenital non-paralytic talipes, the early stage of which we are able to watch, throws light on the congenital affection, the early stage of which is hidden in the uterus. In non-congenital cases of months'

or years' duration, induced by cerebro-spinal affection or by reflex (?) disorder, the vital abnormal spastic contraction co-exists after a time with secondary structural change. We sometimes, however, before structural change has taken place, have an opportunity of witnessing that, although the patient walks with the heel, for example, much elevated, yet when he is seated, even with the knee extended, he can voluntarily bend the ankle,—contact of the sole with the ground exciting abnormal contraction. Further light is thrown upon the nature of the contraction in congenital club-foot by the observation that, during sleep, even in very young infants, the affected foot can be more readily straightened; also that, like as in certain cases of adult hemiplegia, when the child yawns and stretches out the limbs, the inversion of the foot often disappears. This observation would show, that whilst in the ordinary state of the infant's nascent volition the adductor muscles (the tibiales) overpower the abductors (the peronei) and invert the member, the act of yawning, with its complicated reflex activity of inspiratory muscles, and of associated muscles in the extremities, neutralises the peculiar disturbance of muscular activity on which talipes varus depends.

It seems as if in congenital club-foot and analogous distortions a stimulus or irritant were present in the medulla spinalis, acting upon certain ganglionic cells there, which keeps the affected muscle in a state of tonic contraction, yet not sufficient to neutralise the stimulus of the will within the limits of movement permitted by the structural shortening of the member. Many non-congenital spastic contractions appear allied to the condition which prevails in some states of chorea, in which, when the will would permit or cause contraction or relaxation of a particular muscle, an involuntary influence excites contraction, interferes with, and frustrates the voluntary effort. In more intense spasmodic contractions the will is entirely overpowered before structural shortening supervenes to effect the same end.

To resume, then :—clinical observation of non-congenital deformities, springing from derangement of the nervous system, teaches that there are several modes in which they are produced. These modes are as follows :—

1. Paralytic distortions.

- a. Certain muscles only being partially or wholly paralysed, their antagonists slowly contract the dependent articulation.

- b. The muscles of the part in general being partially or wholly paralysed, the contractility of the greater mass, as of the flexors in the extremities, slowly contracts the dependent articulation.
- 2. Spastic distortions.
 - a. The contraction is severe and prompt, the will being quite overpowered or absent.
 - b. The contraction is gradual, as in the majority of (non-paralytic) cases of non-congenital talipes, the will not being wholly overcome (those reputed from teething, for example), but restricted by the morbid innervation, and in time by structural shortening.
 - c. The contraction is gradual but severe, as in the deformities which sometimes accompany imbecility in children. It is probable, in this form, that the contraction is intensified by the co-existence of an enfeebled condition of general volition, a general inertia favouring repose of members, and a greater amount of structural change.

Secondary changes.—From whichever of the above causes a constantly contracted state of an articulation or limb may have proceeded, the state of things consisting of the inability of the individual to put the part, by the action of the will, through all its proper movements is called a deformity. But if the patient by means of his own hands, or if the surgeon, can overcome the contraction, and put the affected part through its proper movements, no deformity is in reality seen to exist. Positive deformity may early exist, when original disease of the joint has, besides producing contraction, ended in more or less considerable alteration in form and structure of the articulation. But almost equally serious (secondary) deformity may ensue through the influence of the now ill-regulated muscles of the joint, especially when these act upon tissues impaired by disease—the production of sub-luxation for example. In the lower extremity, the effects of the weight of the body being borne upon the member in improper directions is a very important cause of secondary deformity, adding greatly to the obstacles to restoration. Thus a not severe case of congenital club-foot, remediable in point of form in a few weeks before walking has commenced, may subsequently require treatment of months or of years; or, from the deteriorating cause above mentioned, be rendered irremediable.

We may now pass to the consideration of the means employed

in Orthopædic Surgery for the rectification of deformities. This department of practice avails itself of much that is common with general medicine and surgery.* Special orthopædic means are, the relieving of the shortened parts by the employment of mechanical instruments, or mechanical power exerted by the hands of the surgeon or assistants, sometimes with the aid of the benumbing influence of chloroform, and by division of one or more of the contracted muscles, tendons, and fasciæ.

Tenotomy, myotomy.—In this operation the necessary relaxation of muscular resistance and of accompanying structural shortening is effected by severing the muscle at its tendinous portion. The principles laid down by Delpech for the performance of this operation are followed in the present day. It is remarkable that Delpech never carried out his own principles.† The discovery and application of subcutaneous tenotomy belongs to Stromeyer. Many alterations in the mode of applying these principles have been made since the original labours of Delpech and Stromeyer. Various knives for severing tendons (tenotomes), and a great variety of mechanical extension apparatus, have been devised. In this place only the means in most general use in this country will be described.

In describing the several distortions in the treatment of which tenotomy and mechanical treatment may singly or conjointly be requisite, no nosological order will be adopted. We will commence with congenital club-foot (*talipes varus congenitus*), because it is one of the most common distortions which the surgeon has to treat, and because it has formed the basis of extensive pathological and therapeutical research. The consideration of the scientific treatment of club-foot will, therefore, best illustrate the principles upon which the management of all other distortions should be conducted.

No other deformity exhibits in a greater degree the incidents of orthopædic experience.

Congenital Club-foot (Talipes varus congenitus).

It is undesirable to attempt here even a sketch of the history of the acquaintance of our profession with club-foot. It will suffice to mention that the subject engaged the attention of

* Constitutional, medicinal, and dietetic treatment, exercises, gymnastics, inunctions, &c.

† See the history of division of tendons, in a *Treatise on Club-foot and analogous Distortions*, by the Author. London, 1839.

Hippocrates amongst the ancients, and of Scarpa amongst the moderns. But it was not until the genius and energy of Stromeyer were combined with a sound acquaintance with the principles and practice of modern surgery, that the complete treatment of severe club-foot became possible.

Anatomy of club-foot.—Former opinions on the anatomy of club-foot may be advantageously passed over.* In 1837, and subsequently, the author laid down the essential characters of the anatomy of club-foot.† The subject has since been carefully and successfully studied by Mr. William Adams.‡ The general result of observations of this matter is the confirmation of the opinions emitted by the author in 1837 and 1839,§ that club-foot consists of a three-fold alteration of the form and position of the foot, the heel being elevated, the toes turned in, and the internal margin of the foot raised from the ground, owing to abnormal action and shortening of the principal, if not of all the muscles of the inner and back part of the leg. Perhaps, also, in at least the severer forms, those in which the sole is much contracted, the plantar muscles participate in the primary affection. The ligaments, fasciæ, and integuments on the contracted side of the member are also shortened, whilst the similar tissues on the opposite side are elongated and weakened. These passive tissues follow the fortunes of the active organs—the muscles, on which they are in the main dependent, and become thus secondarily affected. The bones, before and after ossification, suffer in proportion to the intensity of the muscular contraction, and probably in proportion to the earliness of the period of uterine existence at which the distortion commenced; and especially in proportion to the period that elapses after birth, during which the passive osseous structures remain at the mercy of the active muscular agents. The bones further suffer as age advances, by bearing the weight of the body in an improper direction.

The departure from the normal form and relation of bones may be divided into—

* See *On the Deformities of the Human Frame*, by W. J. Little, pp. 271 et seq. London, 1853.

† *Dissertatio inauguralis de Talipede Varo*, Berlin, 1837.

‡ *Medical Times and Gazette*, 1852; *Transactions of Path. Soc.*, 1856.

§ *Treatise on Club-foot and analogous Distortions*. London, 1839. A large number of treatises on club-foot have appeared since 1837, few of which contain any fundamental researches into the anatomy of varus.

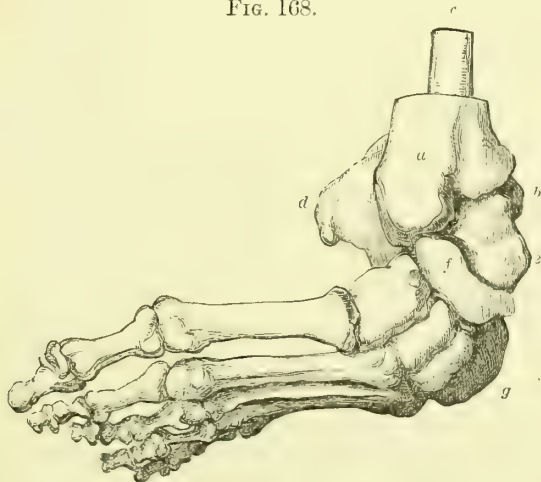
1. Primary.

- a.* The changes especially affecting the tibio-tarsal joint.
- b.* The change of relation of the anterior bones of the tarsus, as regards the astragalus and os calcis.

2. Secondary, or those induced after birth, by spontaneous aggravation of the deformity, and by pressure upon the parts through walking in an improper manner.

The anatomical changes of bones in varus of practical moment are due to the state of extension of the os calcis, taking with it the astragalus, through which the posterior extremity of the os calcis is more or less closely approximated to the posterior surface of the ankle-joint; and the anterior portions of the articu-

FIG. 168.



Severe adult congenital Varus, viewed from the front and inside:—*a*, the tibia, cut down in order to show the relatively posterior situation of the fibula; *b*, the external malleolus; *c*, the fibula; *d*, the posterior extremity of the os calcis, drawn abnormally inwards; *e*, the astragalus, unduly prominent on the dorsum of the foot; *f*, the navicular bone in contact with the internal malleolus; *g*, the cuboid, its proper superior surface applied to the ground.

lating surfaces of the trochlea of the astragalus are projected from the ankle-joint in front. Owing also to the forced inversion of the entire foot, the external malleolus is thrown backwards towards the posterior tuberosity of the os calcis, and the anterior extremity of the astragalus slightly inclines towards the inner margin of the foot. The forced elevation of the posterior part of the foot (calcaneum and astragalus) is common to talipes varus and to talipes equinus; but the characteristic peculiarity of varus is the displacement of the remaining bones

of the tarsus inwardly to the extent that the navicular bone quits the astragalus, often touching the internal malleolus, with which it frequently acquires a new articulating surface. The cuneiform and cuboid bones accompany the navicular. Moreover, in severe cases the cuneiform, cuboid, and metatarsals, with the phalanges, are drawn backwards, limiting the space of the plantar region.

The changes of bones induced by improper walking, improper pressure and bearing against the ground, by which also sometimes inflammation and ulceration of soft parts are occasioned, do not properly belong to simple uncomplicated club-foot. Only when these injuries are considerable do they affect the results of treatment.

The shortening of the ligaments, fasciæ, and integuments on the posterior and internal aspects of the member may be observed when, before or after operation, attempts are made with the hand to rectify the deformity. In severe cases, much resistance to cure is offered by the posterior ligament of the ankle, the deltoid, the calcaneo-scapoid, the superficial and deep plantar ligaments. The share of resistance offered by the deltoid, for example, is well shown when dissecting severe infantile varus. After removal of the superficial textures (integuments, fasciæ, muscles, and tendons), much amelioration of shape results; but the ligaments of the ankle being intact, it is observed that the foot still retains a varus form. But when the deltoid ligament is severed, and the navicular bone is liberated, a marked facility of replacement is evinced.

The general direction of the structures involved in the distortion is much altered. Thus, the leg-bones are inwardly rotated from the knee-joint. The surgeon should not expect to find the tendons occupying their normal relations. Those passing over the front of the ankle-joint are deflected inwardly, whilst the posterior tibial tendon appears more deeply situated, owing to the incurvation, and to the backward dragging, and elevation of the anterior part of the foot.

Etiology of congenital club-foot.—The primary cause of talipes varus congenitus has been already touched upon, p. 660. It consists in an alteration of the dynamic properties of certain muscles, apt to be accompanied or followed by structural shortening,* and by fibrous and adipose degeneration of them.† Until the researches of Rudolphi, it was held that club-foot, as

* Little, loc. cit.

† Cruveilhier, *Anat. Pathol.*; W. Adams, *Pathol. Trans.* loc. cit.

well as other distortions and malformations, were the consequence of some 'occult influences,' *lusus naturæ*, maternal imagination, and intra-uterine pressure. An occasional effort is made to revive the last of these theories, that of intra-uterine pressure. It has been elsewhere shown* that accidental mechanical causes do sometimes act upon the foetus, giving rise to easily recognisable conditions, *e.g.* fissures, clefts, intra-uterine fractures, amputations of members from constriction by abnormal bands or by the umbilical cord; and sometimes the co-operation of pressure by the uterine walls and pelvic bones may be surmised.

The arguments in favour of the belief that ordinary congenital club-foot is caused by some derangement of the cerebro-spinal centres and dependent nerves, as opposed to the theory of its dependence upon pressure of the walls of the uterus, may be thus stated :

Club-foot often coexists with evident derangement of the nervous centres, as in acephalous, hemicephalous, and spina bifida subjects.

Club-foot occasionally co-exists with an analogous distortion of the upper extremity, club-hand, in which the muscles contracted are the anatomical analogues of the parts contracted in the lower limbs. Now if it be admitted that the external configuration of double club-foot may suggest to the unphysiological and unpathological observer the idea of one of the feet having overlapped the other in such manner that the uterus, *supposing* the liquor amnii to be deficient, has compressed the two feet into the form in which we see them, this explanation does not apply to the club-hands, which bear no such form as can be reasonably attributed to pressure of the uterine walls. Moreover club-foot often exists in one foot only, and the uterine-pressure theory does not explain why one foot escapes. This theory is still less applicable to the highest grade of club-foot, in which the great toe is more approximated to the inside of the leg than pressure of the uterus will explain; whilst the opinion of undue (spastic) action of the muscles before the articulating ends of bones can restrict their action, affords an intelligible explanation.

Club-foot is met with in foetuses before the fourth or fifth month of gestation, at which period the liquor amnii is

* *On Deformities of the Human Frame*, pp. 256-314.

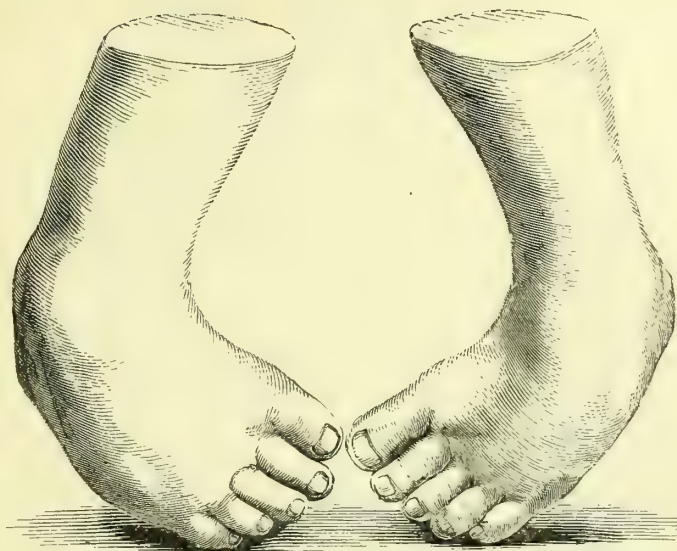
relatively so large as to exclude the idea of uterine pressure consequent upon *supposed* deficiency of that fluid.

Congenital club-foot can often be traced to hereditary influence, sometimes on the father's side, sometimes on the mother's side. We have traced it on the paternal side even through four generations, the male infant, the father, the grandfather, and the great grandfather. If it can be plausibly maintained that club-foot is due to the influence of uterine pressure, deficiency of liquor amnii, pressure of pelvic bones, and its repetition through successive generations, this influence could only be propagated through the female side. We cannot admit uterine influence in hereditary propagation of varus through an uninterrupted succession of male parents.

A comparison of club-foot with the distortions which occur after birth, unmistakably from diseases of the nervous system, tends to prove that congenital and non-congenital club-foot spring from analogous causes. Distortion after birth, from altered innervation of muscles, is more common in the lower extremities, and especially in the feet, than in any other part of the frame. Club-foot is also the most common distortion before birth. After birth, talipes varus, in consequence of cerebro-spinal affection, is more common than talipes valgus; before birth also, varus is more common than valgus. After birth, foot-deformity, from disease of the nervous system, attains oftener a higher grade on the left than on the right side. This is equally the case with congenital club-foot. Some other agency than accidental uterine or pelvic pressure is required to account for these analogies; they cannot be regarded as mere coincidences.

Grades of congenital talipes varus.—It is convenient for practical purposes to divide congenital club-foot into three degrees of severity: the slightest, that in which the position of the front of the foot when inverted is such that the angle formed by it with the inside of the leg is greater than a right angle, and in which the contraction is so moderate that the toes can easily be brought temporarily by the hand of the surgeon into a straight line with the leg, and the heel be depressed to the natural position. The second class includes those in which the inversion of the foot and elevation of the heel appear the same or little greater than in those of the first class, but in which no reasonable effort of the surgeon's hands will temporarily extinguish the contraction and deformity. The third class

FIG. 169.



Congenital infantile Talipes Varus, of medium severity.

FIG. 170.



Most severe grade of infantile congenital T. Varus.

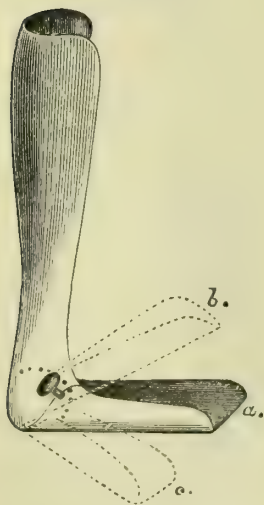
comprises those in which the contraction of soft parts and displacement of hard parts reaches the highest degree, so that the inner margin of the foot is situated at an acute angle with the inside of the leg, sometimes is even almost in contact with it.

Cases of the first and second grades may be respectively converted into the second and third grades by delay in the application of remedies, and by the effects of improper locomotion.

Treatment.—The indications are to overcome the shortening of the muscles, ligaments, fasciæ, and integuments on the contracted side of the member; to direct the bones into their proper position; to educate the patient's voluntary use of the parts; to give strength to the muscles and ligaments on the elongated side of the member, and to combat the tendency to relapse.

A few slight cases may from the day of birth almost be relinquished to the rubbings and manipulations of the nurse;

FIG. 171.



some require to be lightly bandaged on a strip of tin or firmer metal, bent to a right angle, and properly padded; others require support not only beneath the sole, and against the back of the leg, as when a simple bent strip of metal is employed, but need lateral support or pressure against the internal margin of the foot, as by the application of a tin splint devised by the author (see Fig. 171). In the use of this and similar contrivances to be found at the different surgical instrument-makers, the essential point consists in applying the smallest amount of pressure compatible with maintaining the apparatus on the limb, not endeavouring

at once either to force the part straight or even to make the tender infantile foot accurately fit the apparatus, but rather, if the apparatus selected admits of adaptation, to adjust it to the foot in a somewhat improved position. Practitioners unacquainted with the details of management of these cases are surprised to discover how small an amount of pressure suffices in young infants rapidly to improve the form and flexibility.

The splint should daily once, or oftener, be removed to ascertain that undue pressure has not been used, to replace it when loosened by the movements of the child, and to improve the position as often as practicable. No unnecessary loss of time should be permitted during this process, as at first the foot rapidly relapses to its most distorted condition.

If at the expiration of the fourth week distinct contraction of the tendons remain perceptible in spite of assiduous efforts to overcome the deformity by manipulations, frictions, and steady but gentle employment of splint and bandage, or if benefit proportionate to the attention bestowed be not realised, or if the case unequivocally belongs to the second or third degrees of varus, the aid of tenotomy will be required to effect restoration. If the surgeon should entertain doubt whether the time for operation have arrived, he may be determined by the observation whether, on holding the foot in the normal position, it springs vigorously back into the abnormal one as soon as the pressure of the hands is removed. In unequivocal cases of the second and third degrees he may, in most cases, decide affirmatively at the moment of birth on the absolute necessity of future operation; and when operation is indispensable, the earlier the period at which it is performed the better. Mr. Stromeyer Little has operated within twenty-four hours after birth with rapid and permanent success. Our practice of late years has been to operate as soon as convenient during 'the month.' The surgeon, when deciding on the necessity of operation, must not be guided solely by the external configuration, but by the amount of firm resistance opposed to restoration, by the depth of the furrows existing in the sole and behind and above the heel, and by the degree of tension of the integuments about the internal malleolus. The deep clefts or furrows in question denote intensity of contraction of muscles, and closer adhesion than usual of integuments and fasciæ to the subjacent soft structures and bones. They probably denote also that the deformity dates from an early period of uterine existence. Even atrophy, the usual concomitant of contractions of long duration, is already present in severe club-foot of new-born children, and is a measure of the length of time the muscles have been contracted and exposed to structural shortening and possible degeneration.

Nature of the operation.—The essential character of congenital talipes varus being a state of abnormal elevation of the heel,

and inversion of the front part of the foot by undue muscular contraction, the operative interference required consists of the division of the tendons of those muscles which are mainly, if not exclusively, concerned in the production of the deformity, viz. the tendons of the anterior and posterior tibials and the tendo Achillis. In average cases these three tendons may be divided at one operation. In severer cases the operation should invariably be divided into two parts, the first consisting of the section of those structures which contribute to the inversion—the tibiales tendons; and where the sole is much contracted with a strong prominent band felt at the inner edge of the plantar fascia, that band may be included in this portion of the operation. The division of the plantar textures and elongation of the sole may in severe cases advantageously precede the section of other structures. The tendo Achillis may in such cases be severed in three or four weeks; in adults, two or four months later; the inversion having, in the interval, been overcome. The value of this proceeding, first recommended by the author,* consists in the os calcis, when the tendo Achillis is left intact, offering a *point d'appui*, or resisting point, from which the surgeon, during the mechanical after-treatment, is enabled to stretch out and unfold the contracted involuted sole. If this division of the operation into two or three parts is not observed in bad cases, incomplete recovery may result, the sole remain contracted, and the individual walk unduly on the heel, the range of motion of the point of the foot being deficient,—in short, a secondary talipes calcaneus be produced. This secondary deformity is always overcome with difficulty, sometimes it is irremovable.

In a few adolescent and neglected adult cases of congenital equinus and varus, even the peronei may need division, these muscles having become, from protracted duration of the deformity, tensely contracted and considerably shortened.

The following is the mode of dividing some of these tendons, and the instruments which we have introduced as the most appropriate for the purpose. The operation is more quickly and more conveniently done by taking the three tendons in the following order, viz. the posterior tibial, the anterior tibial, and the tendo Achillis. Section of the posterior tibial is best performed by placing the child on a table of convenient height, on

* *Lancet*, May 25, 1839.

its back, inclined towards the limb to be operated on. This should be thoroughly rotated outwardly, resting upon its outer side, whilst a competent nurse holds the child's hands and the opposite leg out of the way of the surgeon. An assistant, having a few small dossils of lint, a bandage, and the necessary knives within reach, takes his place by the side of the patient, and holds the thigh and knee of the limb to be operated on with one hand, being prepared with the other to hold firmly or adduct the foot, as may be required. The operator, when about to sever the left posterior tibial, seats himself in front, takes the foot in his left hand, and endeavours to feel the slight prominence of the posterior tibial tendon with the left thumb; during the time he either abducts the foot with the right, to put the tendon on the stretch, or takes advantage, during the spontaneous movements of the infant, to observe where the tendon is thrown into palpable relief.

When, however, the surgeon cannot feel the tendon, it is practically quite sufficient to make out the inner edge of the tibia, about a finger's breadth above the lower end of the inner malleolus; or should there be any difficulty in defining this ridge of bone in consequence of the fatness of the limb, the careful insertion of the knife *exactly midway between the anterior and posterior borders of the leg*, on its inner aspect, will be an exact guide to the position of the tendon, not forgetting, as anatomy teaches us, that an incision made a little in front of this line might wound the internal saphena vein and nerve; and if made behind it, would run the risk of dividing the flexor communis digitorum instead of the tibialis posticus; or the knife might even pass posterior to the former tendon, and, if carried deep enough, might wound the artery and nerve without touching any tendon whatever.

Having thus determined the situation of the posterior tibial by one or all of these methods, a sharp-pointed knife is passed through the skin at about a finger's breadth above the inner malleolus, according to the age of the child. It must be made to penetrate steadily down, *perpendicularly to the surface*, to a depth varying from a quarter to half an inch. In doing this, it is necessary to be quite sure of sufficiently opening the fascia covering the posterior tibial and common flexor tendons; otherwise, when the probe-pointed knife is passed in (as will be described in the next stage of the operation), it may either hitch against this dense unyielding structure, or glide over its

surface behind the deep layer of muscles, instead of passing through the opening in front of them.

In order, therefore, to accomplish the *free division* of this fascia of the leg close to its insertion into the edge of the tibia, and likewise the proper sheath of the posterior tibial tendon beneath, the sharp-pointed knife should be passed to the depth above recommended; the handle must then be elevated so as to depress the point of the blade; that is to say, the instrument should be used as a delicate lever, the centre of motion being the skin, which may be pressed upon gently by the back of the knife; and in this way an opening of the requisite size can be made in the fascia at the bottom of the wound, without enlarging the external aperture.

Having thus far accomplished the operation, the sharp-pointed knife is withdrawn, and a probe-pointed one is to be passed into the puncture through the skin, superficial fascia, layer of adipose tissue, deep fascia, and lastly the proper sheath of the tendon, and be now inserted a little further in, so as to get well between the posterior tibial and the tibia. When satisfied from the sensation communicated to the knife that the bone is on one side and the tendon on the other, all that remains to be done is to turn the edge towards the tendon, giving the knife a slight cutting motion, while at the same time the assistant firmly abducts and depresses the inner border of the foot.*

A distinct sensation of something having suddenly yielded can be perceived at the time of the division of the tendon; but if the case should have been previously operated on, this feeling may be very slight, in consequence of the adhesions existing between the original wound of the tendon and the adjacent parts.

As soon as this peculiar jerk is detected by the assistant, he should immediately relax the foot, and apply a dossil of lint over the wound, holding it there with the fore-finger during the division of any other tendons. If, as has happened, the artery is supposed to be cut, either from the escape of florid blood or from the blanched appearance and reduced temperature of the foot, it will only be necessary to apply instantly a graduated compress, and to roll firmly a bandage upon the foot and ankle.

* We have seen more than one straight sharp-pointed bistouri caché used instead of two separate knives. The best of these was in the hands of Dr. Dick.

This, however, may require to be loosened if the colour of the toes shows any indication of strangulation. If the operator is not ambidexter, he will find, in the operation for dividing the posterior tibial tendon of the right limb, that he had better stand on the left side of the patient with his back to the patient's face, whilst the assistant sits down in front, and holds the thigh with one hand while he steadies the toes with the other.

Taking, then, the mesial line or the inner aspect of the leg at about three-quarters of an inch above the inner malleolus as the true position of the tendon, the sharp-pointed knife is to be inserted perpendicularly, with its back towards the sole of the foot. It is thus made to divide the skin and deep fascia in the same way as was explained when cutting the left posterior tibial tendon. After this instrument is withdrawn, the probe-pointed knife may now be used to finish the operation, which in all other respects agrees with the section of the corresponding tendon on the opposite side of the body. The long flexor of the toes, owing to its proximity, is often partially or wholly severed at this operation on the posterior tibial.

Weis and Velpeau divide the posterior tibial tendon at its insertion into the navicular bone, the knife being inserted so as to meet the tendon about an inch (in the adult) below and in front of the inner malleolus. This plan is inapplicable to infants. In adolescents and adults this tendon is usually so prominent to the eye and touch above and behind the internal malleolus, that it is an easy matter to sever it by inserting the point of a narrow straight scalpel at the posterior edge of the tendon, directing it forwards between the tendon and tibia, so as to divide it without risk of injury to the posterior tibial artery or the internal saphena vein. It is unnecessary to give particular directions for division of the plantar fascia when needed, those given respecting operations on other tendons being amply sufficient. The direction of the knife should be from without inwards, *i.e.* from the external margin of the foot towards the internal margin.

The division of the anterior tibial tendon in talipes varus should follow the section of the posterior tibial; the patient being in the same position, and the assistant still holding the limb, and pressing his finger upon the lint covering the puncture already made above the ankle. The operator should feel for the most prominent part of the tendon over the joint,

somewhat nearer the malleolus than in the normal foot, and insert a sharp-pointed knife, with its flat surface towards the outer edge of the tendon; and having passed it well beneath, he should turn the sharp edge towards the tendon, whilst the fore-finger of the left hand is pressed gently over the part, to warn him of the approach of the knife to the surface. The assistant, who has been steadily abducting the foot during the operation, gradually relaxes his endeavours as he feels the tendon yield; and as soon as he perceives the distinct snap which is the result of its complete division, he should immediately relax his hold, and apply a small dossil of lint over the puncture.

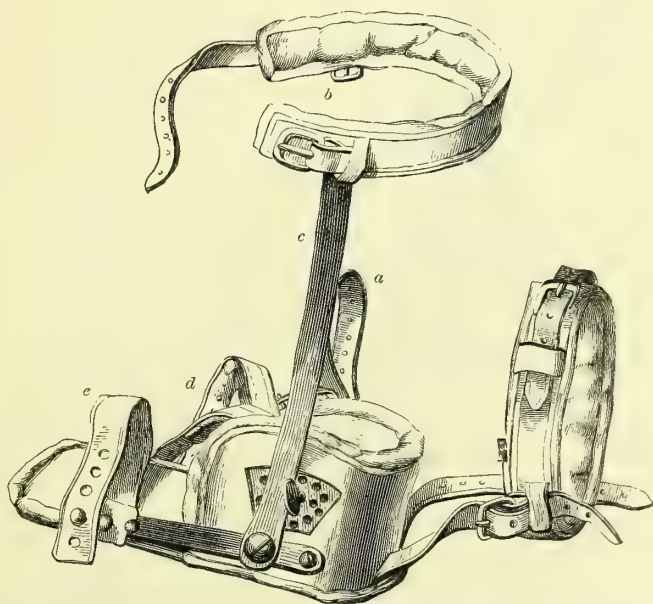
Division of the tendo Achillis is accomplished after turning the infant over on the abdomen. Whilst an assistant endeavours to bend the ankle, the surgeon introduces a small straight tenotome through the integuments from behind forwards at the side of the tendon. As soon as the point of the instrument is judged to have reached the anterior surface of the tendon, it is passed in front of it; the cutting edge is then directed to the tendon, severing the tense cord by one or two movements of the blade against it, and without wounding the integuments, except by the puncture of entry. The assistant should carefully relax the pressure he may be exercising upon the foot in proportion as he feels the part is cut through.

These operations, when properly done, occupy not more than a few seconds each, and are usually absolutely bloodless. Much has been written concerning the danger of wounding the posterior tibial artery. I have only once witnessed any trouble from the circumstance. This accident occurred to a former colleague. Ligature of the vessel on account of a small filbert-sized aneurism was required the third week after the operation. In that instance the wound in the vessel would have probably healed without aneurism if the surgeon had not too soon after the accident incautiously removed the bandage and abducted the foot. When injury of the vessel is suspected or known to have occurred, the removal of the bandage and commencement of the mechanical after-treatment should be delayed three weeks.

A pasteboard or soft metal splint, previously moulded to the form of the contracted part, should be employed immediately after the operation, to ensure quiet, and favour healing of punctures.

Apparatus required after operation.—The metal splints already recommended for cases relievable without operation are equally applicable after division of tendons. Three days after operation, one of these splints, not much straighter than the affected foot, should be selected, or if a splint capable of being adjusted by a screw be used (Fig. 171), it should be set at an angle or in a direction that the child will bear without complaint. In infants above the age of two or three months, a more elaborate and effective apparatus may be employed, when the pecuniary circum-

FIG. 172.



Dr. Little's Shoe for Varus of left foot:—*a*, strap to be attached to the buckle *b*, intended to moderate the action of the lever-spring *c*; *d*, two straps which start from within the heel-piece on the outer side of the foot near the sole-piece, and are intended to be secured to buckles on the opposite side of the instrument, for the purpose of holding the posterior part of the foot firmly against the inside of the shoe, whilst the strap *e*, and short spring to which it is attached, draw the front of the foot outwardly. The convalescent may take exercise in this apparatus.

stances of the parents permit it. The woodcut, Fig. 172, represents the lightest, the most effective, and the most inexpensive of the more elaborate apparatus constructed for the purpose. The perpendicular lever and the toe-spring are derived from Scarpa's shoe; but as Scarpa's apparatus contains no contrivance for depressing the heel, but relies simply on the effect

of the weight of the body acting during locomotion, the author has introduced the movable thumb-screw, capable of being inserted into any required hole of the quadrant shown as above. This is an improvement upon the male and female screw, and the double-acting ratchet-screws often used for the purpose. The simple arrangement of a movable thumb-screw has, in addition to lightness, the advantage of permitting mobility of the ankle in the direction of bending—a circumstance of much importance.

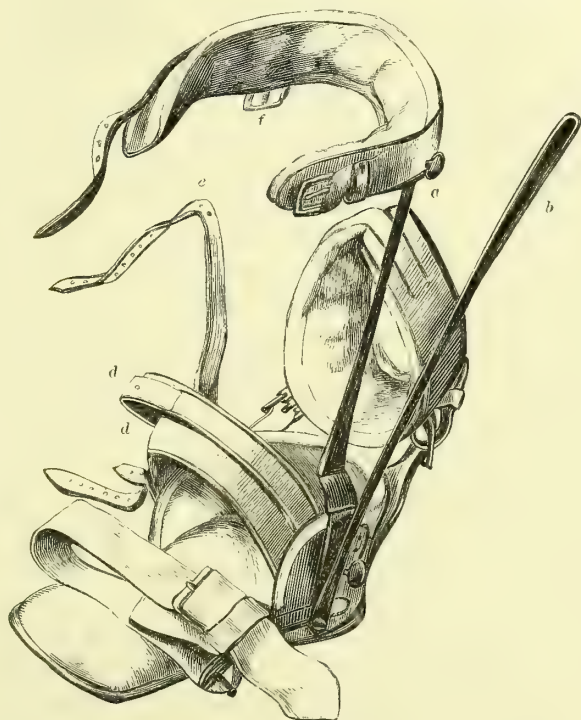
Cases of the first grade of infantile deformity are usually rectified in two or three weeks, those of the second grade in about four weeks, and those of the highest grade, the operation and the mechanical treatment having been divided into two or three stages, within two or three months. The treatment of adolescents and adults varies from two to twelve months.

Relapse not rarely occurs after the most complete flexion and abduction has been obtained. It takes place insensibly, at all ages, especially when growth is most rapid, and is due to too early discontinuance of instruments, and to neglect of manipulations and of passive and active exercises. The worst so-called relapses result from previous incompleteness of operation or of restoration. No case should be considered finally cured until the mental development of the patient is sufficiently advanced for him to take an interest in his cure, and to be able voluntarily to hold the part in a perfect position, and perform the natural movements of it. In relapsed cases repetition of tenotomy is not commonly required. Often the *tendons* will be found of ample length; sometimes the diminutive belly of the gastrocnemius, for example, wasted through want of the stimulus of adequate alternate flexion and extension—*i.e.* proper exercise—being shortened and drawn up towards the popliteal region. A common cause of relapse is doubtless the previous insufficient curative elongation of the fasciæ, ligaments, and muscles situated on the contracted side of the member, and is favoured by the corresponding relaxation and weakness of structures on the opposite side. Continuous gentle re-application of the extending apparatus, aided, as soon as flexion to the right angle is reached, by exercise with a wedge of cork beneath the front of the sole, suffices to restore these cases usually within a few weeks—*i.e.* within the period the patient would have been required to lie up if tenotomy had been repeated. It is satis-

factory to be able, not only to spare the patient and friends the concern incidental to any operation, but to be able to avert, by mechanical means only, without loss of time, the discredit which attaches to the repetition of the operation.

In the treatment of relapsed adolescents, an apparatus that

FIG. 173.



Dr. Little's double-hinged upright Shoe for severe rigid Varus of left foot:—*a*, stiff upright, hinged in two places, which when applied to the leg adapts itself to any degree of deformity; *b*, a spring curved outwardly, which when brought into contact with *a* can be then secured by means of a swivel-stud; *d d*, two straps for purposes similar to straps *d*, in last figure; *e*, moderating-strap, to be secured to *f*, as required. If the act of bringing the spring *b* into contact with *a* should occasion too much strain, *b* can be fastened at any required distance from *a*, by means of a tape. In the application of a varus shoe, success depends much upon the nicety with which the sole is applied to the sole-plate of the apparatus, and upon careful adjustment of the power employed. The foot-part of the shoe should be properly applied before the upright lever is secured. The moderating-strap is the last to be fastened.

will bear the risks of walking exercise, and at the same time favour mobility of the ankle-joint in the required direction, is afforded by Fig. 173.

After operation for club-foot, even in infants, continuous application of splints or other apparatus is required for four or

five weeks; in older children, for two or three months. The less severe the case, the more often the apparatus may be removed for cleanliness, and to examine lest undue pressure is employed. It is the boast of successful treatment of club-foot to be able to accomplish this result without a single excoriation. The surgeon should watch that, in his efforts to depress the heel and abduct the foot, the part be not too long maintained in one position, to the extent that the power of lowering the toes and of inverting the foot is lost; or, in other words, a valgus be engendered in exchange for the varus. This secondary valgus has been attributed to the non-union of the severed posterior tibial tendon. It is really due to too long-continued retention of the foot in an abducting apparatus. We have witnessed it in children born with varus, who had been treated without operation. Its production is favoured by the same constitutional debility which produces spurious valgus, or flat-foot, in rapidly-growing children, who have previously had perfect feet.

Instrumental treatment is further required during at least a portion of each twenty-four hours, until the individual is enabled to plant the entire sole evenly and properly upon the ground, to thoroughly flex and extend the part at will, and habitually, when walking properly, to evert the toes. In numerous cases a child requires no apparatus after the age of five or six months; but the majority need some instrumental aid, such as leg-irons to evert the entire extremity until the intelligence is sufficiently awakened—say, until the age of three years. The maintenance of the ‘cure’ depends, as in all diseases, greatly, if not mainly, upon the individual or his natural guardian. We have had cases under observation off and on from infancy to puberty, owing to successive relapses, which have more commonly occurred abroad or in the colonies. We have witnessed examples of adults returning to be re-operated on, who have been successfully referred to their own efforts, with a few instructions as to mechanical attention.

After tenotomy no replacement of the part should be attempted until after the puncture has cicatrised. Much has been written respecting the propriety of immediate replacement. It is unnecessary in slight cases, and impossible in severe ones. In slight cases, nothing is gained by it; for if the position may be immediately rectified, the part cannot be immediately used. The limb should therefore be gradually replaced while the tendon is consolidating itself.

The influence, in interfering with union, of too-considerable and too-early separation of the ends of a severed tendon, and especially of frequent motion, as in walking, is incontestable. Experiments upon animals have proved that considerable lengths of tendon may be excised, and union nevertheless ensue; but the knowledge possessed of the great extent of the powers of the economy is an insufficient reason for neglect of those rules of caution which experience dictates. The immediate separation of a severed tendon to too great an extent should be avoided. Half or three-quarters of an inch may be safely borne, although as a rule gradual separation is preferable. The condition of a severed tendon approaches that of a fractured bone; too great separation of the severed ends, depression of temperature sufficient to suspend active arterial circulation, too-early movement of the parts, and inherent vice of constitution, may cause tendon, like bone, to remain ununited.

Stromeyer has suggested, that previously to operation the patient should be accustomed to wear the replacing instrument. This plan is desirable when the practitioner is unfamiliar with the treatment of deformities; for he thereby becomes versed in the action and mode of application of the apparatus, and is rendered certain beforehand of the appropriateness of the contrivance.

With reference to the choice of the apparatus, Stromeyer has rightly remarked, that every practitioner will select that of which he best understands the action and mode of application. This sagacious observation explains also one cause of the zeal with which each writer advocates his particular appliance.

It cannot be too strongly insisted upon, that in a large number of deformities, whether treated with or without operation, expensive instruments are unnecessary. More depends upon the tact, patience, and perseverance of the practitioner than upon the particular apparatus employed. Common roller bandages, with or without starch and plaster of Paris, tin, wood, or gutta-percha splints, aided by manipulations, may, in ingenious hands, supply the place of the most elaborate contrivances.

It may sometimes happen that no instrument is available, and the after-treatment may require to be conducted entirely by manipulations. Thus an adolescent case of double congenital varus was admitted into the London Hospital, under the care of Mr. Critchett, presenting large ulcers with necrosis on the dorsum of each foot, induced by pressure during the mechanical

treatment after tenotomy. As the unhealthy character of the ulcers depended upon want of air and exercise, and the application of suitable instruments was impossible, it was determined not to wait for cicatrisation of the ulcers, but to repeat tenotomy, and effect forcible manipulations of the members. Chloroform was upon one occasion employed. By these means the feet were gradually straightened, cicatrisation of the ulcers was thereby favoured, and within three months the lad quitted the hospital entirely restored.

After congenital varus, as after acquired deformities, retentive apparatus may be required; these for the most part consist of jointed irons to support the weak articulations, and springs to assist the action of the debilitated muscles.

The completeness of recovery in the great majority of the cases of congenital varus constitutes one of the triumphs of surgical art.

During childhood congenital varus may be entirely cured, without other traces of deformity than smallness of the member, greater squareness of the front of the foot, and sometimes less complete mobility of the ankle-joint, the patient recovering entire volition. When the case is unattended to before adult age, the internal margin of the foot may never be completely applied to the ground, owing to the impossibility in some cases of perfectly unfolding the os cuboides from its inferior and rotated position in the tarsus; in other instances, owing probably to the round head and neck of the astragalus having become so much inverted in relation to the remainder of the bone, that part of the undue convexity of the tarsus outwards becomes irremediable. Every year reduces the number of adult cases of varus requiring treatment, so that the consideration of any means of meeting the attendant difficulties may appear superfluous. The author has usually found a most efficient agent in a firm pad placed in the sole beneath the os cuboides, pressure being at the same time made upon the upper surface of the other tarsal bones.

Congenital Talipes equinus, Talipes equino-varus, Talipes valgus, Talipes equino-valgus, Talipes calcaneo-valgus, and Calcaneo-varus.

By talipes equinus is understood morbid contraction of the muscles of the calf, and consequent depression of the toes, the adductors being unaffected. This is a very rare congenital

affection. We have met with two cases in the same family—the first born, and the last child, the eleventh. When it has not been treated in infancy, locomotion is effected on the inferior extremities of the metatarsal bones and phalanges. In severe cases the internal margin of the foot is slightly inclined inwardly, and the metatarsus is projected forwards. There is not, as in varus, any disposition to tread exclusively on the outside of the fifth metatarsal bone.

The existence of congenital talipes equinus has been emphatically denied. It is a question of fact and capability of discrimination. It may be suspected that the rare cases of congenital equinus which may have fallen under the observation

FIG. 174.



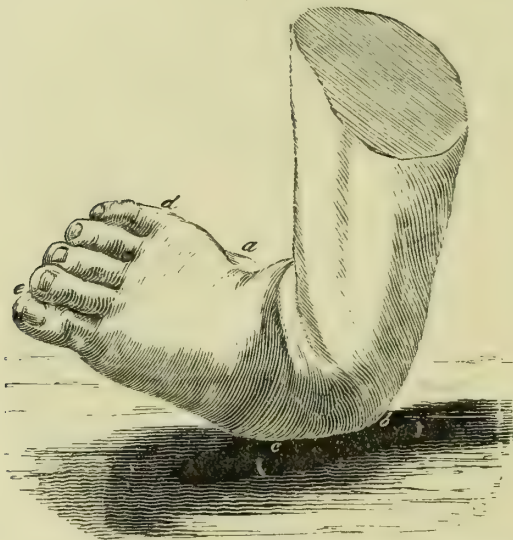
Congenital Talipes Equinus.

of those who have denied its existence have been erroneously classed as varus. In congenital contraction of the muscles of the calf, owing to the morbid elevation of the heel, the narrow portion only of the trochlea of the astragalus is retained within the malleoli, and the front of the foot falls or is drawn readily either inwardly or outwardly; the more ready or usual direction being inward; just as we see in some sound children there is a preponderance of the adductors (tibiales) over the peronei, and the feet are consequently observed to be turned in more often than out. Consequently the surgeon who makes no allowance for the ordinary tendency of the feet to incline, and who con-

siders a case to be varus when he sees the foot with never so slight an inward inclination, does not believe in the existence of congenital talipes equinus.

The few cases of unoperated congenital adult equinus which we have seen have remained talipes equinus throughout. The patients have continued to walk on the metatarsal extremity of the great toe, as well as on the little toe.* The great toe has never been raised from the ground, as it is in congenital varus.

FIG. 175.



Front view of a congenital Talipes Valgus of the right foot of a boy aged four years:—
d a, the outer edge of the foot raised from the ground; *e*, the great toe raised from the ground, although the internal edge of the foot is directed towards it; *b*, the internal malleolus; and *c*, the internal extremity of the navicular bone, being the parts upon which the patient walked.

No original or secondary affection of the adductors had drawn the foot in, so as to resemble congenital varus or even non-congenital equino-varus. The patient, we repeat, still walked on the great toe and the little toe.

If congenital equinus be rejected upon the ground that must be taken by those who deny its existence, then it may as justly be asserted that neither does non-congenital talipes equinus exist; for there is no non-congenital talipes equinus in which a

* We have recently examined an adolescent with well-marked hereditary congenital equinus. It was further remarkable by constituting the fifth example of the deformity in living members of the family, viz., the father, two paternal uncles, and one aunt.

trace of inversion or of eversion cannot be discovered, which when very marked is termed either talipes equino-varus or talipes equino-valgus.

The dispute as to the existence or non-existence of congenital talipes equinus continues for the same reason that discussion is endless in every department of natural history, as to whether a given object belongs to one species or forms another species; one observer recognising a radical difference, which another

FIG. 177.

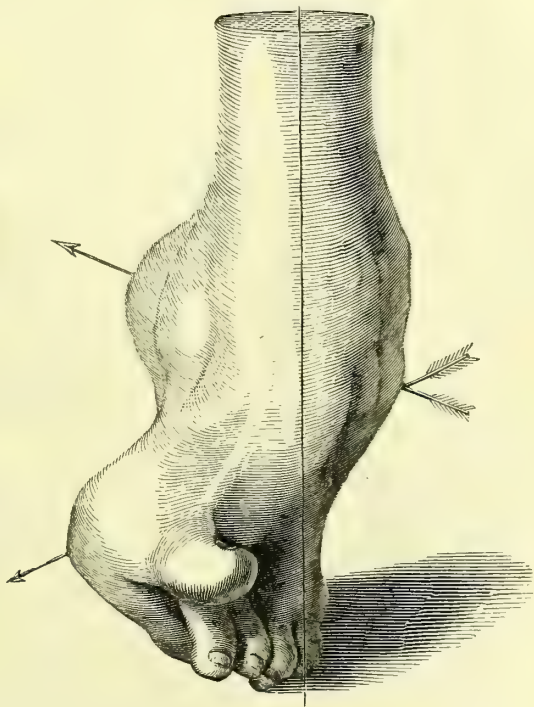


FIG. 176.



Extreme Congenital
Calcaneo-Valgus.

T. Equino-Varus. The arrows indicate the direction of the convexity of the tarsus and metatarsus, forwards and outwards; the perpendicular line through the axis of the limb shows the extent of the inward deviation of the metatarsus, by which the base of the little toe, being brought completely beneath the axis, has to support the entire weight of the body in walking; and is, in consequence of its attrition against the ground, a considerable cause of suffering.

observer either overlooks or explains away as belonging to another species.

Talipes valgus, equino-valgus, and calcaneo-valgus, are the terms applied to those distortions which contrast most with

talipes varus, or ordinary club-foot. The front of the foot is more or less turned out in each of these varieties, instead of being inverted as in varus. In valgus the peronei are the muscles mainly contracted; in equino-valgus the tendo Achillis is also tense, and the heel elevated, the toes at the same time pointing outwardly. In calcaneo-valgus the heel is depressed through the contraction of the anterior tibial, and the toes pointed outwardly from tension of the peronei.

The foot deformities named respectively equino-varus and equino-valgus are both non-congenital, and offer other points of

FIG. 178.



Talipes Equino-Valgus, from loss of power in anterior tibialis, and consequent contraction of calf muscles, and of peronei.

FIG. 179.



Fully developed Calcaneo-Valgus, from paralysis of gastrocnemii and consequent contraction of muscles of the sole, of anterior tibial, and peronei muscles. In some instances the anterior tibial shares the fate of the gastrocnemii.

analogy, the chief of which is their dependence upon either spasmodic or paralytic contraction as the case may be.

The reader, on comparing Fig. 177 with Fig. 169, will perceive the similarity of form between equino-varus (a non-congenital affection) and congenital varus, and might reasonably conclude that little reason exists as far as external form is concerned for making any distinction between them. An essential difference is, that congenital varus is fully formed at the time of the child's appearance in the world, whereas equino-varus, when it proceeds from paralysis, is gradually produced, slowly attaining the

maximum of distortion. In spasmodic equino-varus also the distortion resulting from either obvious or obscure disorder of the nervous system is rarely complete *ab initio*; on the contrary it is for the most part slowly developed. The analogy of equino-valgus (Fig. 178) in some respects with equino-varus is apparent. In both there exists contraction of the tendo Achillis; both are produced after birth from either spasms or paralysis. In equino-valgus the toe is everted, and not inverted as in varus.

The deformed, enlarged, and protuberant heel of talipes-calcaneo-valgus is the consequence of several years' locomotion on the posterior extremity of the os calcis. This bone has in effect, in the fully-developed deformity, a nearly vertical instead of the nearly horizontal position which obtains in the well-shaped foot.

The rules already laid down for judging of the necessity for tenotomy in varus and of the number of contracted tendons to be divided, apply to each of the distortions now under consideration. The principles which should direct the mechanical treatment are equally applicable. The experience of the surgeon and the ingenuity of the instrument-maker are required to adapt the apparatus to the peculiarities of each case.

A variety of congenital varus occasionally presents itself, in which the inner margin of the foot is slightly raised, the sole contracted, and the dorsum prominent towards the outer side of the foot, but without elevation of the heel. In these cases the muscles of the ankle are unaffected. We have designated this affection calcaneo-varus. The treatment consists in making pressure by means of a pad upon the prominent dorsum, and in suitable manipulations. A beneficial result is soon observed; but the affection is prone to return. Division of the plantar fascia and of the long flexors of the great toe rarely exercises as much permanent benefit as is expected, because the quantity of plantar textures necessarily left unsevered suffice after cessation of the treatment to reproduce contraction.

Some irregular *congenital* foot-distortions are met with. In a few of these we find distinct paralytic loss of muscular power: in one case well-marked paralytic varus, with much atrophy of the soft and hard parts; in another, paralytic contraction of the hips, knees, and feet, with implication of the upper extremity. The only treatment applicable is to relieve contraction by manipulation, friction, and in unyielding cases by tenotomy, thus offering a chance to the muscles which remain partially

under the will, to support the individual in attempts to effect imperfect locomotion. We have watched these cases from birth to adolescence; in many the paralysis has remained undiminished.

Distortions originating at the moment of Birth.

We have seen that in the earliest times of the study of congenital distortions, they were successively attributed to the anger of the Deity, *lusus naturæ*, malposition in, and pressure of, the uterus. In the present day, an enlarged observation of non-congenital as well as congenital distortions leads irrefragably to the conclusion, that the numerous causes which are found to operate in the production of distortion after uterine existence, exercise analogous if not identical effects, whilst the foetus remains within the uterus. These causes are, hereditary and maternal influences, disturbance of the nutritive, respiratory, circulatory, and nervous systems of the foetus and infant, accidents, entanglement by the funis and abnormal bands, intra-uterine fractures, malposition and pressure, fixed repose in one position, and inflammation. In order to illustrate the obnoxiousness to distortion existing at every epoch, we shall here describe a group of distortions, which unquestionably take their origin at the period intervening between uterine and independent life, that is, *during* birth. We believe we can particularise the moment, as that moment which connects placental with pulmonary respiration. When we reflect upon the important phenomena in the economy at the moment when it should adapt itself to the immense changes involved in the abrupt transfer of the oxygenating process of the blood from the placental to the pulmonary cell surfaces, we should anticipate that any retardation, interruption, or arrest of this transfer of the most important function should be attended with the greatest evil to the system at large, and especially to the nervous system, the most susceptible in the body.

We know that a state of suspended respiration and animation is the common consequence of many of the accidents attendant upon birth; and we might infer, from the evils often witnessed after recovery from the asphyxia of drowning or of choke-damp, what might be the consequences of the apnoea and asphyxia of new-born children. Some of these appear, however, to have escaped notice, until the observations published by the author in 1843. The lungs suffer in the form of atelectasis; the heart

probably in delayed or deficient closure of the foramen ovale, and possibly in straining of its walls; the nervous centres from effusions and apoplexy, followed by impeded developments, atrophy of individual parts, sometimes by impaired intellect and volition, convulsions, and spasmodic contractions.

It is scarcely necessary to add, that difficult and instrumental labours, and those in which the cranial bones and brain, and even the vertebræ and their contents, have suffered mechanical injury, are more likely to be followed, if not by death, at least by general convulsions and other serious derangement of the nervous system, of which a prominent symptom are the 'internal' or subdued convulsions of the nursery.*

A common class of affections resulting from injury at birth, whether the injury be mechanical or vital, consists of a peculiar diminution of volition with tonic rigidity, in varying degrees of a part or of the whole of the muscles of the body, described as 'the spastic rigidity of new-born children.' Both lower extremities are more or less generally involved. Often one limb only is referred to by the parents; but careful examination usually shows a smaller degree of impairment in the limb supposed to be unaffected. This state of peculiar spastic rigidity of young infants may even continue through the whole duration of life. We have known patients over forty years of age thus affected from birth.

The amount of contraction in the hips, knees, and ankles is often considerable, and the leanness proportionate to the contraction. The flexors and adductors of the thighs, the flexors of the knees, and the posterior muscles of the legs preponderate. The thighs and knees cannot therefore be completely extended, or the heels be applied to the ground. In some cases the upper extremities are held down by the preponderating action of the pectorals, teres major and minor, and latissimus dorsi; the elbows are semi-flexed, the wrists partially flexed and pronated, and the

FIG. 180.



Spastic contraction of flexors and adductors of the lower extremities, consequent on asphyxia neonatorum. Similar distortion may result from 'convulsions' during teething and other cerebro-spinal affections.

* See *Transactions of the Obstetrical Society*, 1862.

fingers incapable of perfect voluntary direction. Participation of the muscles of the trunk is sometimes shown by the shortened, flattened aspect of the pectoral and abdominal surface, as compared with the more elongated, rounded form of the back. The prominence of the back partially disappears on recumbency; but the greater weakness of the muscles on the dorsal aspect of the trunk is obvious when the individual again attempts to sit upright. The inability and indisposition to exert the abdominal and other muscles concerned in the expulsive processes may, perhaps, sufficiently explain the tendency both to rare micturition and defecation, which sometimes exists. The muscles of speech are often involved, the affection varying in degree from inability correctly to utter one or more letters of the alphabet, up to the entire loss of the articulating power. During the earliest months of life, deglutition is often impaired. The intellectual functions may suffer from the slightest impairment, which the fond parent unwillingly acknowledges or fails to perceive, up to entire imbecility or idiocy. The functions of organic life are unaffected, except perhaps that of development of caloric, although the depression of temperature may be more dependent on the want of proper exercise. The appetite is good; the frame generally, in average cases, is well nourished, although with less than the average adipose deposit. The child is often described as the healthiest of the family, escaping epidemics, or having these disorders less severely than the brothers and sisters. These subjects often lead a more precarious existence during the first weeks after birth; at first even vegetative life languishes, often because premature birth or difficult labour, by impairing the maternal supply of nutriment, renders more difficult the infant's recovery from the shock the system has received. However, in the majority of instances, after restoration of the vegetative functions, a gradual amelioration of all the functions of animal life is perceptible.

Although at first convulsions are the rule, the *spastic* contractions are not present, or are not observed, until some weeks after birth. The child's limbs are simply weaker; the convulsions and the question of viability alone occupy the thoughts of the attendants. Before the age of three or four months, though sometimes in slight cases not until the ordinary time for locomotion has arrived, the nurse perceives that she is unable properly to separate the thighs or knees for purposes of cleanli-

ness; that the child never thoroughly straightens the knees; that he does not attempt to stand, or is incapable of standing except on the toes, or that the feet are disposed to cross each other. Even children slightly affected rarely 'go alone' before the age of three or four years; many are unable to raise themselves from the ground at that age, and others do not walk even indifferently at puberty. Locomotive ability seems to advance in proportion as the intellectual powers are developed. The external form of the cranium occasionally exhibits departure from the normal type—such as general smallness of the skull, depression of the frontal or occipital region only; sometimes of one lateral half of the skull, sometimes of one half of the occiput only.* In slight cases the head has been well developed. The *ensemble* of phenomena points to injury more or less extensive of the cranial contents, and especially of the medulla oblongata and spinalis.

In all cases, even with great inertia as to the exercise of volition, common sensibility appears little if at all deficient. On the contrary, a morbid sensibility of the organ of hearing and of the cutaneous envelope appears to exist, evinced by 'startling' at the slightest noises, and extreme sensibility to touch. This morbid sensibility may be due to a condition of spinal cord analogous to that present in narcotized frogs, in individuals under the influence of strychnine, or those affected by tetanus. It may, however, be apparent only, dependent upon the individual, when subjected to common noises, being less competent quietly and promptly to reason upon them, and by thus reassuring the easily disturbed nervous mind, to escape from the exciting influence. In many cases the intellect has been intact. A peculiarity of these children—an uncommon fear of falling—is often observed when they are seated on a couch, less when they are on the floor, and not observed when they are seated in an arm-chair; a circumstance clearly due to conscious inability to balance and recover the position of the body.

* Morbid Anatomy reveals in these cases a corresponding deficiency in size of the affected parts of the cranial contents.

Spastic Contractions from Cerebro-spinal Disease in Infancy and Childhood.

We have just described a state of more or less general spastic contraction, which results from disturbance of the cerebro-spinal centres at the moment of birth, either from direct injury to the cranium or neck whilst passing through the maternal parts, or, more probably, from asphyxia consequent upon interruption to the substitution of pulmonary for placental respiration. Sometimes, without either premature or difficult labour having preceded, convulsions occur very soon after birth, during the first hours, days, or weeks of independent existence. Convulsions, as is well known, occur more frequently after dentition has made some progress, whilst the infant is undergoing another transition, that of passing through the crisis from nourishment by the mother's breast to feeding, when unfavourable consequences of deprivation of breast-milk are apt to show themselves. The infant may be of previously unexceptionable history, except that the parents may be the subjects of disorders of the nervous system, of nervous temperament, have overtasked brains, have been phthisical, or are intemperate. These convulsions now and then leave the sufferer impaired in mental power, and affected with spastic rigidity, undistinguishable from that which succeeds apnœa and asphyxia neonatorum. (See Fig. 180). It is scarcely necessary to add to the previous remarks on spasmodic and paralytic contractions that convulsions and other cerebro-spinal morbid states of childhood may be followed by spastic contraction, or paralysis of single muscles or of sets of associated muscles.

Treatment.—The indications for either the operative or mechanical treatment of these different forms of spastic and paralytic contractions, and the mode of conducting the treatment, are the same as those laid down in speaking of congenital club-foot (p. 670), modified by the nature of the cause of contraction. In contradistinction to congenital contractions, we may remark, that in contractions occurring during teething, the occurrence of structural shortening may generally be prevented by timely-applied manipulations, frictions, mechanical support to paralysed parts, or assistance to the antagonists in the case of spastic affections. It should be remembered as a reason for avoiding unnecessary tenotomy, that the contracted

muscle is often the healthier one, and that in the case of a spasmodically affected muscle, tenotomy does not 'cure' the spasm. It is often only temporarily beneficial, and sometimes transfers the preponderance to another set of muscles, merely substituting one evil for another. In severe general spastic contraction, the surgeon has carefully to balance the good and evil, one against the other.

Flat-foot, or spurious Valgus.

This common deformity presents externally many of the characters of congenital valgus, and of the acquired valgus which results from paralysis of the anterior tibial muscle. But the resemblance is only superficial. The person treads unduly on the inner margin of the foot, the toes are turned outwardly, and the arch of the foot is diminished, or, in severe cases, may be obliterated; hence the term flat-foot. True valgus springs from congenital contraction of the peronei muscles; spastic non-congenital valgus from spasm of the peronei; paralytic valgus from partial or total paralysis of the anterior tibial; sometimes combined with paralysis of the posterior tibial, causing contraction of the peronei owing to the want of antagonists; but spurious valgus or flat-foot is due to general want of tone in the fibrous structures of the body,—displayed in the yielding of one of the parts of the frame most exposed to strain, the plantar muscles and ligaments; hence sinking of the arch, eversion of the toes, and secondary contraction of the peronei. After a time the displacement of the tarsal bones, connected with the sinking of the arch, leads to painful or difficult locomotion and limitation of the movement of the ankle-joint. Finally, the tarsus may be said to be convex inferiorly, concave superiorly, the anterior part of the foot being then drawn up by the conjoint action of the anterior tibial and the extensors of the toes, and the heel held tensely upwards by the muscles of the calf. Even in moderate cases contraction of the peronei is distinctly felt; in severe cases shortening of the remaining muscles above enumerated is also evident. In the worst cases scarcely any mobility of the ankle-joint remains. A slight degree of flat-foot is common in girls, especially amongst those of fine organisation in the upper and middle classes of society; less frequent in boys; and is curable amongst them by considerably reducing the

amount of standing and walking exercise, by substituting horse exercise where practicable, by avoiding too fast walking in the company of adults, by early hours, by avoiding competitive over-study, by generous living, fresh air, tonics, attention to the state of the *primæ viæ*, embrocations, and manipulations directed to the promotion of inversion of the foot and prevention of the threatened contraction. In greater relaxation of the parts about the inner ankle, actual confinement to a couch, and carriage-exercise for a month or five weeks, or that time

FIG. 181.



Severe Flat-foot or Spurious Valgus.

spent on the sands or beach at the sea-side, will lay the foundation for cure. Laced boots, supported at the sides with stiff leather or thin steel busks, are of great assistance in walking. An elastic horse-hair, india-rubber, or felt pad beneath the inner margin of the foot tends to support the arch. Iron and cork, often employed for this purpose, are harsh and inefficient. We must utterly condemn a practice often resorted to in contempt of the pathology of the affection—that of severing the *peronei* and *tendo Achillis* in all such cases. The recovery of patients from moderate flat-foot when this operation has been performed, is due mainly to the absolute repose of the limb with which the operation is followed, and to the mechanical measures concurrently employed. But in a few rare cases in private practice, and in those of boys who have stood prematurely behind a counter twelve or fourteen hours daily, and amongst the

lower classes in public institutions who have suffered from premature labour, the deformity has existed so great a length of time that the contracted muscles have become shortened and rigid, rendering tenotomy, with its promptness and certainty of action, a necessary adjunct to the mechanical treatment.

Flat-foot often exists for several years without attaining even an intermediate grade of severity, when all at once a particularly long walk, a leap, or initiation into a standing occupation, becomes the starting-point of a considerable and rapid aggravation. Sometimes evidence of chronic inflammation of the calcaneo-scapoid ligament, or other plantar structures, or a painfully stretched condition of the plantar nerve, exists. This last symptom is recognised by the exquisite, unbearable, electric-like, painful, tearing sensation described by the patient when he takes a long stride, or stands on the affected leg alone. We should not be induced to operate on flat-foot even on account of its long duration, or of palpable shortening of the tendons before enumerated, since even rigid contraction of muscles, healthy as to their innervation, will yield in a few weeks to judicious frictions, manipulations, disuse of the part (required in this deformity owing to its special exposure to aggravation by walking), and mechanical treatment. As an argument in favour of severing the Achilles and other tendons in slight cases, we have heard the question put, 'What harm does the section do?' Now, although the tendo Achillis is very tolerant of the ever-ready operator's scalpel, it cannot be pretended that an unnecessary operation is a benefit. As, in extremely severe cases, the act of walking, after replacement of the tarsal bones, tends to bear down again the tarsal arch, the aid of mechanical appliances is subsequently needed for several months, or even sometimes for two or three years. Relief is much more readily obtainable in the child than in the adult. The apparatus available in these cases is the same as that used for varus, but with the action of the springs, screws, or lever reversed.

Subcutaneous division of the peroneus longus and brevis is effected in a manner similar to the operation of severing the tendo Achillis. The patient should lie over on the opposite side, an assistant holding the foot inwardly, so as to maintain extra tension of the parts. The tenotome should be introduced in front of the tendons, the section proceeding from before backwards.

Contractions of the Upper Extremity from Spasm and Paralysis.

The principles which should direct the application of tenotomy to spasmodic and paralytic contractions of the upper extremity are those which are applicable to other parts of the body, except in so far as the functions of the individual muscles of the upper extremity, especially those of the wrist and fingers, are more delicate, varied, and complex than, for example, are those of the corresponding parts of the lower extremity. We should be prepared to expect that a surgical proceeding which aims at intercalating a piece of new tendon, with the object of reducing the range of action, and therefore the power of a rebellious spastic muscle, or for the purpose of thereby weakening a healthy muscle so as to favour a partially paralysed antagonist to recover its activity, would be less successful than in the lower extremity, the actions and movements in which are comparatively simple. The acquirement of the power of progression, even if it be incomplete, amply compensates for the sacrifices the patient makes; in bad cases he is satisfied with the possession of a limited flexion and extension of the hip, knee, and ankle, and can be aided by mechanical appliances. But in the case of the wrist and fingers the individual derives little benefit from these simple movements, and he cannot be materially assisted by any complicated mechanism hitherto invented. We have divided the biceps at the bend of the elbow, the rigid well-defined pronator radii teres at its muscular portion, the tendons of the flexor carpi radialis and ulnaris where most prominent close to the wrist, and have found the resulting benefit proportioned to the attention subsequently bestowed upon manipulations, passive exercises, and painstaking education of the enfeebled non-contracted extensors. Except in cases of many years' duration, in which the retracted muscles were reduced to inextensible fibrous bands, it has seemed that as much ultimate benefit was obtained by manipulations and exercises as by the employment of an operation, and at no greater expenditure of time. The prognosis must be based on the amount of improvement that may be expected in the affected portion of the nervous centres. As an encouragement to treatment, the surgeon should remember that cases occur in which the disorder of the nervous system and nerves has ceased, and that he has to deal only with consequences. This observation applies also to many congenital contractions.

Deformity from Disease of the Palmar Fascia.

A not uncommon contraction in the upper extremity consists in a permanently flexed condition of one or more fingers, with visible and palpable thickening and hypertrophy of the fascia investing the palmar surface of the first phalanx of the affected finger and of the neighbouring portion of the palmar fascia. Sometimes the whole of the fingers and thumb are implicated, the palm itself is contracted, and the use of the member as a prehensile, and even as a tactile, organ almost destroyed. The ring and little fingers, the middle finger, index, and thumb, are usually affected in frequency and degree in the order in which we have placed them.

The articulations are commonly unaffected, although occasionally that of the first phalanx, with the second phalanx, or this with the third, has exhibited slight arthritic enlargement. On endeavouring to straighten the fingers, the surgeon feels that a general resistance is offered by the tissues of the entire palmar surface of the hand and fingers, and especially by the indurated palmar fascia itself. Any existing tension of the flexor tendons cannot be felt along the fingers, but in the palm, particularly in the upper part, above the edge of the most indurated part of the palmar fascia, one or more prominent and tense tendons may be felt. This deformity is usually attributed to injury, often to a trifling wound, to irritation by the use of a whip in driving, of a walking-stick, or mechanical tool. These mechanical causes, or local irritants, if really operative, can be regarded only as occasional determining or exciting causes. The essential or primary cause is a constitutional one, allied to the gouty or rheumatic diathesis. We may not venture, however, to assert that the constitutional cause is identical with that of gout or rheumatism, as the persons affected have appeared singularly free from other manifestations of those affections. The disease of the palmar fascia, unlike gout or rheumatism, is painless. Many patients affected with considerably contracted palmar fascia in both hands present similar induration of the

FIG. 182.



Contracture of palm and fingers from disease of palmar fascia.

corresponding fascia of the soles; a sufficient proof that the complaint is essentially independent of the mechanical causes assigned for it,—unless, indeed, we assume that the act of walking by stretching the sole can act upon the plantar fascia after the manner of a mechanical irritant. The symmetrical character of the affection, the precise resemblance of one case with another, the occasional existence of hereditary gout in the family, the frequent occurrence of the same deformity in father and son for several generations (four), as well as the above facts, confirm the opinion of its constitutional origin. We have never witnessed this complaint in the female. Those who have freely indulged in strong wines and spirits, or beer, are the frequent subjects of it.

We regard it, then, as a painless chronic induration of the fascia, leading to compulsory, gradually-increasing disuse of the fingers and hand. Through this disuse the flexor muscles and tendons, which are probably free from the original affection, assert their preponderance over the equally idle extensors, and become gradually affected with secondary shortening.

Treatment.—Even in tolerably advanced cases, frictions, manipulations twice or oftener daily, the application of a screw-adjustment splint, or straight splints of wood, tin, or gutta-percha, will, if suitably and perseveringly used, reduce the contraction and deformity. But at the advanced age at which many patients present themselves for relief, the employment of mechanical apparatus encounters many difficulties. In rigid unyielding cases of long duration, tenotomy is remarkably efficacious. We cannot by its means alter the constitutional state, or directly remove the induration of the fascia; but we are enabled to remove by tenotomy the secondary tendinous contraction, to take the case entirely out of the influence of the patient's will, so far as the contracted muscles are concerned, and obtain a starting-point for further benefit by mechanical treatment. A puncture half a line in width suffices for the passage of a firm tenotome beneath the tendon in the palm. The tendon is thus divided from below upwards. No fumbling or unnecessary handling of the part after the operation, by which means air or blood might be disseminated amongst the palmar tissues, is permissible. The operation, like most subcutaneous operations, is bloodless. We have invariably seen the puncture heal within forty-eight hours. Considerable yielding of the contracted finger, the tendon of which has been severed,

is at once perceived. Manipulations and mechanical treatment complete the cure. We have frequently thus effected entire restoration of the hand and fingers. It is remarkable that the indurated fascia softens, and the hard ridges and corresponding furrows in the fascia disappear, under this treatment. It is obvious that the afflux of blood to the part excited and maintained by the frequent manipulations, frictions, and bandages, alters the nutrition of the part, and removes the previous morbid deposit. It is also probable that caution as to diet and wine whilst under the observation of the surgeon, assists this process of recovery. The causes being constitutional, and the attention of the patient being liable to slacken after a lengthened recovered use of the member, the complaint occasionally returns. We have re-operated on a patient thrice in eleven years; the individual expressing himself amply compensated for the operation by nearly as many years' good use of the part. This operation is a valuable illustration of the success of subcutaneous tenotomy compared with Dupuytren's painful operation, even when performed by so able a surgeon as the late Sir A. Cooper. We have had under observation two cases in which, by means of a large crucial incision of the palm, the indurated fascia had been dissected out and removed. The operation had no better result than that of causing a large contracted cicatrix, more rigid than the former state of things, and quite irremediable.

Wry-Neck.

Torticollis, or wry-neck, is a not very uncommon distortion of the head and neck, originating, like club-foot, from a variety of influences; some acting through the muscles—congenital, spasmodic, paralytic; others acting through the ligaments and bones—rheumatic and strumous. Occasionally the point of departure of a case is strumous affection of the lymphatic glands, and sometimes loss of textures from sloughing after burns or a gun-shot wound.

Congenital wry-neck.—This is the most common form of wry-neck. It is perceived a few months or more after birth, and, when suffered to proceed unchecked, gradually increases during childhood, adolescence, and adult life, until it attains the proportions of a formidable deformity. Many cases of wry-neck, reputed to be congenital, have appeared to originate from accidents at birth, in consequence of breech presentation, turning, &c.

We will describe an adult case, in which the right sterno-cleido-mastoideus is the head and front of the offending, for it is probable that other muscles are always either primarily or secondarily involved. The entire head leans to the right side and slightly forwards, the right side of the neck is somewhat hollowed, whilst the left side is unnaturally convex, and the patient not unfrequently complains of pain in this situation.

FIG. 183.



Wry-neck from spastic contraction of sterno-cleido-mastoideus.

These changes in the form of the neck are more pronounced at the upper part, *i.e.* opposite to the base of the cranium, that being the region most influenced by the contracted muscles. The chin is drawn to one side and approaches the left shoulder; the right ear is approximated to the sternal extremity of the clavicle. The sterno-cleido-mastoideus of the affected side (right) has lost its symmetry, being reduced to a comparatively narrow, hard, tight cord, three inches in length, the muscle of the opposite side measuring five and a half inches. This prominent cord is double below, representing the double origin of the muscle. In the adult a marked upward bend of the clavicle is often seen where the clavicular portion of the contracted muscle arises, induced by the constant abnormal traction to which the bone has been subjected, and the inferior portion of the muscle itself appears of cartilaginous or osseous hardness, and is lost in a large bony process on the protuberant clavicle. If we examine the neck and shoulders posteriorly, we observe that the cervical vertebræ have yielded to the dragging

of the contracted muscle; this part of the vertebral column presenting a convexity on the left side, which is compensated for by a curvature in the opposite direction lower down. The right side of the head, neck, and right shoulder are considerably smaller than the parts on the opposite side; the right shoulder and scapula being unduly raised. A singular effect upon the face results from this difference in size, combined with the impediment to the function, which the abnormal position of the head involves. In the adult case from which we describe, so great is the difference in size between the two sides of the face, that on the right side the external canthus of the eye is distant from the external angle of the mouth three inches, whilst on the left the distance amounts to three and a half inches. The inclination of the head to the right causes the right eye to be habitually situated on a still lower plane than would be the case if atrophy of the affected side were alone operative. The atrophy and the slight bending forwards of the head interfere with the direction and use of the right eye, and cause a peculiar expression of archness and sense of difficulty and suffering. These features of the deformity are, as already mentioned, proportionally less marked in early life.

The principal muscles of the neck are probably involved, the trapezius and scaleni, as well as the sterno-mastoid. In this and other respects congenital wry-neck offers much analogy to congenital club-foot. The principal contraction affects in both cases muscles which pass over more than one articulation, the sterno-cleido-mastoid in one case, the gastrocnemius in the other; hence in the neck the mischief of morbid contraction may effect a higher degree of deformity than if the contracted muscle influenced one articulation only; in the leg the contracted gastrocnemius does not always limit its evil influence to the foot, but may contract and distort the knee. In both wry-neck and club-foot other muscles participate in the deformity; but the range of influence of these being less, or being counteracted by antagonistic powers, their contraction is not so apparent. It is an interesting question of physiological pathology, whether there is anything special in the anatomy and function of the sterno-mastoid and gastrocnemius, that they should obtain the distinction of entering into so large a proportion of cases of congenital and acquired deformity. The gastrocnemius, by its great development, its greater nervous supply, and its relation to the upright stature and locomotion

of man, is certainly entitled to a peculiar and elevated rank in comparative and human myology; so, when we reflect upon the size of the sterno-cleido-mastoid, its relation to the large vessels of the head and neck, its deriving its nerve-power mainly from a special nerve (spinal accessory), and remember the influence of this muscle upon the act of respiration, we cannot deny it a pre-eminent function amongst its neighbouring muscles.

We have elsewhere shown* that not unfrequently wry-neck appears to result from straining or injury to the neck during difficult labour, from traction of the head by instruments. It is superfluous, after what we have said of the causes of congenital club-foot, p. 666, to refute in detail the theory which would attribute wry-neck, like club-foot, to accidental uterine or pelvic pressure. Congenital wry-neck clearly originates from causes acting through the nervous system.

Treatment.—It is probable that, as with slight congenital club-foot, so slight cases of congenital wry-neck, if early detected, are removable by frictions, manipulations, and subsequent education; but all the cases we have seen, varying in age from four to forty-five years, have exhibited so much contraction and proportional secondary deformity, that we have in no case delayed division of the sterno-cleido-mastoid. It has always seemed justifiable to gain at once, by means of this operation, a large measure of relief; thus affording an encouraging starting-point for the after-labours of the attendant in overcoming the shortening of the integuments, platysma, fasciæ, associated muscles, and ligaments on the hollow side of the neck, and, in this way, gradually acting upon the altered relation of the articular facets of the inclined vertebræ.

Division of the sterno-cleido-mastoideus is performed subcutaneously, upon the principles practised by Stromeyer in division of the tendo Achillis, viz. effecting the division by the smallest possible wound in the integuments and the narrowest tract through the subcutaneous tissues, and avoiding any external bleeding or extravasation of blood into the areolar tissue, or admission of air into it. Neglect of these precautions would be calculated to excite suppuration and prevent immediate healing of the puncture, and delay untowardly the employment of the necessary after-treatment, until, perhaps, the severed

* *Trans. Obstet. Soc.* 1862.

tendon might be reunited and implicated in the surrounding adhesions, the case thus becoming less amenable to the necessary mechanical treatment than before operation. The spot chosen for the operation should be that at which the tendon springs rigidly across the important subjacent organs, and where consequently most space is afforded for introduction of the tenotome beneath the tendon without risk to those organs. In wry-neck this spot will be found from a half to one inch above the clavicle. It is also more easy to sever the muscle entirely by keeping at this distance from the bone. In some cases we have found the sternal portion only developed and rigidly contracted; a few weak fibres attached to the clavicle having, before the knife reached them, yielded to the tension maintained by the assistant. In cases in which the clavicular origin of the muscle is broad, it is safer to divide the sternal and clavicular portions each by a separate puncture, rather than pass the knife by one puncture made in front of the neck as far back as may be necessary to reach the whole of the clavicular portion. This precaution is justified by the anterior and posterior edges of the muscle not being on a plane surface; for although the fasciæ of the lower part of the neck may usually bind down sufficiently the vessels and nerves, and so keep them out of danger, it is well to remember the liability of meeting with abnormal distribution. The complete division is accompanied by a very sensible crack, and the head at once assumes a much improved condition. We have measured immediately after operation, and have found the difference in length between the affected and sound muscle reduced more than one-half. The puncture should at once be covered with a compress of lint, and a common bandage be applied. We have found no harm result in the case of the sterno-cleido-mastoid in allowing the ends to separate as far as they were inclined to yield. In young and flexible subjects, we have found adhesive plaster and a common roller-bandage an amply sufficient mechanical contrivance to aid in rectification of the head. Apply a long strip of adhesive plaster around the forehead and occiput, its maintenance in position being better secured by a bandage passed over the vertex and beneath the chin, the two being pinned together where the one passes over the other, above the ears. Next attach around the waist a broader band of adhesive plaster, not so tight as to interfere with the movements of the ribs; over this a turn or two of

calico roller-bandage; the two should be fastened together by a stitch here and there. The surgeon has now two circular bandages, the one around the forehead, the other around the waist, which are not likely to slip if properly applied. He should then sew a strip of ribbon to the head bandage directly above the ear of the unaffected side, and carry it diagonally across the trunk to the opposite side of the waist bandage, and there pin it. By this means the left mastoid process (we are speaking of wry-neck caused by contraction of the right sterno-mastoid) will be drawn towards the right sterno-clavicular articulation, the original wry-neck be removed, and the chin brought to the median line, or in young and flexible subjects even across it, towards the affected side, constituting a temporary wry-neck in the opposite direction. The circular or ovoid form of the cranium renders it difficult to act upon it for any length of time by any apparatus hitherto invented. The apparatus will shift its direction, or rather the head will partially disengage itself. Hence even a greater necessity for manipulations exists in wry-neck than in other deformities. No apparatus effects so beneficial and lasting an impression upon the distortion as the hands of the surgeon or attendant. Whilst one holds down the shoulders, the other, standing or sitting behind the patient, should apply firmly his flat hands to the sides of the head, and direct the chin, vertex, or occiput in the required directions. The patient should be placed on a lower seat. Such manipulations need to be done with due caution and technical skill. It is not necessary to cause pain in order to produce much good. They should be employed three times a day. The plaster and roller-bandage which we have described is most convenient in reference to these manipulations. It may be unpinned in a moment, and as quickly readjusted. We have cured many cases by the means here enumerated, in periods varying from one to three months, and have never had occasion to repeat the operation. Manipulations as a precaution against relapse may be longer resorted to; but the patient's voluntary efforts are more employed, for obvious reasons, and are more successful, than in some other congenital deformities. An apparatus similar to that described p. 707, for rectification of the position of the head in deformity from vertebral disease, may be employed in cases of adult congenital wry-neck during some portion of every twenty-four hours. It readily effects re-position of the

lateral or forward inclination of the head, but is powerless to affect the abnormal rotation of the head round the horizontal axis.

Acquired or non-congenital spasmodic wry-neck.—We have seen several cases of active, violent spasm of the sterno-mastoid in both sexes, oftenest in unmarried females of middle and advanced age, causing severe wry-neck. The spasm is commonly jerking, irregular, convulsive, never ceasing entirely whilst the patient is awake. The disorder has usually commenced about the age of thirty in subjects not obviously hysterical, persons of excellent intellectual and social character, whose families have seemed prone to other cerebro-spinal affections. We have watched several of these cases for many years. The spasm and deformity have in many cases gradually increased, often rendering the patient's existence distressing, through incessant motion of the head, disturbance of sleep, and pain in the neck, apparently due to strain of ligaments and nerve-disturbance, and sometimes accompanied with pain referred to the upper part of the spinal cord itself, as in some cases of 'spinal irritation.' Now and then the spasm is so considerable that the ear of the affected side is drawn down by a series of jerks so as almost to touch the clavicle. The patient's voluntary efforts to arrest the pulling down of the head appear to increase the disorder. Sometimes the co-existent affection of the trapezius draws the head at the same time backwards, and prevents the chin approaching the sternum. In inveterate cases, such as have existed many years, we have employed mineral and vegetable tonics, galvanism, and electricity, with only temporary benefit. However, as might be expected, generous diet, hygiene, and freedom from mental disturbance, alleviate the symptoms. Complete relief is afforded by subcutaneous tenotomy of the affected sterno-mastoid; but even this measure is only useful for a time; for after two or three months, or as soon as reunion of the severed part is complete, the spasmodic shortening and jerking return. Stromeyer had a patient who submitted to two repetitions of tenotomy for the sake of the temporary relief afforded by the operation. The author once operated on an elderly female who had suffered from spasmodic wry-neck upwards of twenty-five years. She had been unable for many years to sleep in the recumbent position, but dozed in a high-backed nurse's chair, provided with side-supports for the head. For a few nights after the

operation she slept soundly in bed. The malady, however, returned, and she ultimately sank exhausted, want of sleep appearing to be a principal cause of the fatal result. The operation on the sterno-mastoid is insufficient to affect the remaining muscles, which are sometimes involved.

In two recent cases of this affection, such for example as have existed less than two years, we cured the patients in a few months, using bromide of potassium. In others the use of the perchloride of mercury has had the most satisfactory effect. In every case which the author has cured, using internal remedies, the value of attention to the primæ viæ has been apparent. For this purpose, half a grain of the ext. aloes barbad. every night has been used. It is not improbable that the utility of hydr. perchlorid. and of argent. nitr., in these and analogous cases, is due to their stimulant action upon the hepatic and alimentary mucous surfaces, rather than upon any direct specific action upon the nerve-tissue serving the implicated muscles. Relapse is not uncommon after every mode of treatment.

An interesting instance of almost perfect cure of an inveterate case in which mere section of the sterno-cleido-mastoid had proved only temporarily beneficial, is fully recorded by Mr. Campbell de Morgan in the *British and Foreign Medico-Chirurgical Review*, July 1866. The successful operation consisted in division of the external branch of the spinal accessory and the removal of a piece of the nerve, about a quarter of an inch in length. The patient was seen some two years afterwards with only faint traces of the disorder.

Paralytic wry-neck is rare; we have not seen more than three cases. The head is drawn to one side by the healthy muscle, which is deprived of its antagonist. Sometimes a case occurs in which, in consequence of difficult birth, the head falls helplessly to one side more than is common to new-born infants, probably from mechanical injury to some of the structures in the neck. Such cases resemble wry-neck from paralysis, but differ by the history, and by the evil being less confined to the sterno-mastoid. These weak necks from injury at birth, as far as we have had the opportunity of watching, have gradually recovered. In paralytic wry-neck, when the stage for ordinary treatment of the partial paralysis has passed, we can do no more than support the head by the padded-leather or steel-spring cravat. Except when the unparalysed sterno-mastoid is structurally degenerated or very rigidly contracted, and is insusceptible of elongation by manipulations or mechanical treatment, it would be as irrational to employ

tenotomy as it is in a case of contracted gastrocnemius, which has simply lost its antagonist, and which can be relieved by a suitable mechanical support without operation.

Wry-neck from disease of the cervical vertebræ is caused by strumous, and sometimes by rheumatico-strumous disease of one or more cervical vertebræ, from which the head inclines to the affected side. The chin is directed to one side, although this feature is less marked than the sideward falling of the head. In bulging of the opposite side of the neck, and in general appearance, these cases much resemble congenital wry-neck, but are distinguished from it by their history, the pain on motion, the aspect of strumous or constitutional disorder, by hectic, by the instinctive aversion of the patient to the surgeon's handling of the head, and concomitant glandular or other forms of strumous disorder in the one case, or rheumatic affection in the other. The pathological changes common to disease of the vertebræ in each region, and its peculiar dangers when situated in the neck, are described in a subsequent essay. Great caution is necessary in handling these cases, lest the disintegrating bones give way suddenly to the pressure, or the reparative process which may be going on be interrupted. Much benefit to the disease itself, and gradual improvement in the position of the head and neck, may be effected by a well-adjusted supporting and rectifying apparatus, as well as by the recognised medicinal, dietetic, and hygienic treatment of the constitutional malady. We have twice witnessed death as sudden as in apoplexy, in cases in which suitable support of the head had been neglected, and the patients had persisted in maintaining the erect position, having walked about supporting their heads with the hands. The most efficient apparatus consists of a padded metal plate, secured by straps beneath the axilla and around the chest upon the shoulder of the side to which the head inclines. From this shoulder-pad an iron upright piece extends upwards, by the side of the neck, to the parietal region. The lower end of this upright is attached to, and moves upon, the shoulder-plate by means of an endless ratchet-screw; the upper end is connected with a pad intended to be adjusted and pressed against the parietal region. In adults and very severe cases, this apparatus may be attached to a common spinal support for the chest and pelvis, for the sake of greater fixity and more powerful leverage. Sometimes an iron stem is required to extend upwards on one or both sides of the head,

with connecting straps to be applied beneath the chin and occiput, so as to receive the weight of the head. Much opportunity for the ingenuity of the instrument-makers is afforded by these cases. In the present day we do not commonly find it necessary to employ the cumbrous and unsightly machines, consisting of an iron scaffold and gibbet for suspension of the head, to which surgeons resorted as lately as the commencement of the present century.

Knock-knee, In-knee (Genu valgum).

This frequent deformity, of which instances are met with at all ages, consists of an inward yielding of the knee-joint, in consequence of weakness of the ligaments and muscles which respectively connect or surround the articular extremities of the femur and tibia. Its causes are identical with those which produce in-ankle or flat-foot (*talipes valgus spurius*), p. 693.

Abnormal states of general nutrition in children and adolescents, dependent upon insufficiency or improper quality of food, are a common predisposing cause of this deformity. Sometimes it appears probable that the constitutional weakness, or laxity of tissue, has been engendered less by unsuitable supply or quality of food than by imperfect assimilation, owing to deficient aëration of the blood, as in children reared in confined dwellings, both in town and country. In many cases, the abnormal nutrition proceeds to the length of developing an unmistakable rachitic condition, known by the co-existence of the peculiar curvatures of bones which characterise that disease. Our observation of the numerous gradations of knock-knee met with in young children, varying in outward appearance from the most flourishing health to the most miserable, wasted, and dwarfed extreme rickets, has convinced us that even in the slighter forms of knock-knee a degree of impaired assimilation of food and an abnormal state of blood, similar to that present in rachitis, exists. In these slighter cases of knock-knee, traces of rachitis will be found in prominence and deformity of the cartilages of the ribs, flattening of the sides of the chest, and sinking-in of the sternum. One or more severe attacks of bronchitis, or broncho-pneumonia, have frequently been with justice regarded by the friends as the forerunner of the 'weakness of the limbs.' In many instances the earliest link in the chain of causation has been an error in the infant's diet; namely, the

substitution, for an insufficient supply of breast-milk, of farinacea boiled in *water*, with the addition of little, if any, cow's milk. Sometimes we may ascend a degree higher, and discover an hereditary pathogenetical influence. We have several times observed knock-knee in small, delicate, prematurely-born children; the limbs, as a consequence of general weakness, having yielded to the superincumbent weight of the trunk. Such cases should not be confounded with the *inverted* flexed and contracted knees which occur in children who, in consequence of premature birth, have suffered from asphyxia neonatorum (p. 688). Knock-knee often shows itself before the child has attempted to walk, this act being occasionally delayed by it as much as three or four years. When the deformity attains a certain grade, it may increase rapidly from the effects of walking, or it may increase so gradually as not to excite the parent's anxiety, until at length, about the age of seven, ten, or twelve years, the child is again 'thrown off the feet,' and becomes incapable of walking without crutches or other support. The deformity often takes place in tall, rapidly-growing lads from the age of twelve to eighteen, who may have exhibited no previous tendency to it. Undue exercise, and fatigue in standing and walking, with late hours and the poisoned atmosphere of ill-ventilated places of business and dormitories, appear in such individuals to have contributed to the complaint. Undue strain upon a sound limb, in consequence of some other defect in the opposite limb throwing increased exertion and weight upon it, may produce this deformity.

Treatment of knock-knee.—We have heard it maintained, that, as a rule, children recover spontaneously from this affection. In a small proportion of cases, spontaneous recovery of good power of walking takes place; but an examination of such instances has shown us evident traces of the affection in some persistent enlargement of the internal condyles, with inability to take long walks on several successive days, without weakness and pain on the inside of the knee. Slight cases will recover under improved dietetic and hygienic influences, with the aid of suitable manipulations, and the discontinuance of prematurely teaching the child to walk. Sometimes we can, in addition, advantageously recommend the recumbent posture during certain short periods of the day, and combine with this repose the placing a soft pad between the condyles, the limbs being extended, and the ankles being gently drawn towards each other

by means of a soft bandage, strap, or other ligature. In carrying out this plan, we require to watch that the knees be not too fully extended, *i.e.* bent backwards beyond the horizontal line of the couch; a condition apt to ensue as another consequence of undue laxity of articular ligaments. In worse cases, more persistent mechanical means are requisite; simple padded wooden splints, a short one applied behind the knee to prevent flexion, and a long one reaching from the trochanter to the malleolus externus, not too tightly bandaged, may suffice. Modifications of such splints, constructed of metal or wood articulated at the knee, furnished with a ratchet-screw to permit adjustment to the inward inclination of the knee, and secured by straps and buckles, may be found at most instrument-makers'. On the whole, even in moderately severe cases, but especially in aggravated cases, no apparatus is so efficient as a well-constructed iron to extend from the pelvis, on the outer side of the limb, sometimes on both sides of the limb, to the bottom of the shoe, the hip and ankle joints being left free, the knee *fixed* in a somewhat improved position; which may be further rectified from time to time, as the progress of the case demands, by means of the adjusting screw or straps. The surgeon should see that the apparatus is constructed with due regard to the anatomico-pathological and the mechanical wants of the case. For example, irons, to be promptly effective, need to take suitable points of support against the upper part of the outside of the thigh and the lower part of the outside of the fibula.

Severe cases require the knee to be prevented from bending when standing, during a period varying from three to six months; then freedom of motion during a part of each day for a similar though variable period; and, lastly, perfect freedom yet a few months, before discontinuance of the support. The total average duration of treatment of bad cases in advanced childhood may occupy two years. Care should be taken to employ daily frictions and manipulations, so as to prevent the knee becoming stiff in an extended position. We were formerly accustomed, in severe in-knee of adolescents, to aid the mechanical treatment by previous section of the outer hamstring; but the observation of the length of time occupied in the treatment notwithstanding the tenotomy, and indeed a conviction forced upon us that the operation did not appreciably shorten the treatment, has caused us for many years past to discontinue

recourse to it. In adolescents the most severe cases will recover with the aid of manipulations, exercises, and mechanical apparatus, without confinement to the couch; but until a straight limb is obtained, recumbency, by removing the weight of the trunk, greatly accelerates recovery. We are bound emphatically to protest against the operation of removal of a wedge-shaped piece of bone from the upper part of the tibia, performed by M. Meyer for the cure of this deformity. It is a sufficient condemnation of this severe operation to remind the reader that knock-knee is not dependent upon curvature or deformity of the tibia, but upon a removable displacement of the relation of the articular extremities which enter into the knee-joint. Consequently, an operation of the kind performed away from the joint is at best a clumsy proceeding, and not without danger. Division of the external lateral ligaments, another operation recommended for knock-knee, is also unnecessary.

Occasionally the knee-joint yields outwardly instead of inwardly, constituting a deformity exactly the opposite to knock-knee. We have named this affection, *Genu extorsum curvatum*. The treatment of it should be conducted upon the same principles as that of knock-knee.

On Orthopædic Operations applicable to the Removal of Curvature of Bones.

Under the section on Rachitis in this work the value of mechanical treatment of curvature of the long bones of the lower extremities will find appropriate mention. In very early childhood whilst the curved bones are still in the softened stage, the straightening of them with the aid of splints, strapped or bandaged on the parts, may when the treatment is conducted with gentleness and patience be successfully accomplished, or 'irons' may be substituted for splints. The bent rachitic bones of the forearm may also, in the early stage of the disorder, be straightened by splints or with the help of spring instruments. So also the long bones of the lower extremities in adolescents affected with the singular and pathologically speaking little understood disease variously denominated 'mollites osseum, osteomalacia, rachitismus adultorum,' may be easily straightened by mechanical means.

It is different when, in ordinary rachitis, the bones have reached the stage of normal induration or 'eburnation.' On

such bones mechanical pressure makes no perceptible impression. In the adult, therefore, affected for instance with tibia and fibula of ivory hardness, and bent to an angle of 75° or 80° , the limbs being shortened several inches, the act of walking being laborious and painful, owing to the consequent and undue strain upon the ankles and knees, which become affected with genu valgum and talipes valgus spurius or flat-foot, the question has arisen whether such an individual, insusceptible of help from irons, shall be left incurably lame.

A case of this nature was submitted for my opinion by Mr. L. Stromeyer Little. The case was that of a young adult female otherwise in good health and free from deformity in the upper half of the frame. It was agreed that relief might be obtainable from removal of wedges of bone from the tibia and fibula and subsequently placing them in the straight position, and their treatment after the manner of accidental compound fracture. The difficulty in deciding on the propriety of such an operation resulted from the uncertainty whether bones thoroughly 'eburnated' after rachitis could, when severed surgically, for the cure of distortion, be confidently expected to reunite after the manner of an ordinary compound fracture of healthy bone. No known facts bearing on this point, such as the history of a fractured rachitic 'eburnated' bone and its reparation, were available to help the decision. After reflection upon the manner in which reparation is effected after fracture of a healthy bone, it was decided that reunion of the artificially divided eburnated bones would take place. The operations took place at the National Orthopædic Hospital. The tibia and fibula of each leg were severed and wedge-shaped pieces removed, the periosteum having been scrupulously respected as much as possible.

The operations presented no unexpected difficulties. They were arduous, owing to the depth at which great part of the sawing had to be accomplished, and the blunting effect of the hardened and enlarged bones upon the best tools. The leg first operated on did not heal without the supervention of two moderate abscesses, and the throwing off of small necrosed particles. The health did not suffer. After six months the patient left the hospital with one straight limb, the inversion of knee and flat-foot having been simultaneously overcome. She returned to the hospital after six months' absence and requested to have the second limb operated on. The experience acquired by the first operation was not lost upon the second. This time she made a more speedy recovery and had no abscess. A year and a half after the first operation she walked with the help of a stick, having two straight limbs.

Mr. Little operated on an analogous case of bony curvature in the upper extremity. A boy suffered from inability to pronate the fore-arm, owing to the bones having become deformed during infancy from softness and irregular muscular contraction. The fore-arm was constantly fixed in a state of supination, diagnosed to result from the unduly arched radius being locked in its movements by contact with the ulna. Section of the radius, placing it in a normal position, and healing of the artificial compound 'solution of continuity,' resulted in a few weeks without any disturbing symptom and with the desired beneficial result.

These operations, fairly indicated and eminently successful,

offer an encouraging page to the orthopædic surgery of bones. As in other departments of orthopædy, it may be hoped that increased attention to such deformities in their early stages may render the opportunity of important surgical interference less frequent than we have witnessed.

Anchylosis of the Knee and other Articulations.

The successful labours of orthopædic practitioners have contributed to improve the knowledge of the real condition of joints after the cessation of various forms and degrees of inflammation and degeneration. The erroneous notion, that long-continued repose of a joint alone sufficed to induce such alterations in its articular surfaces as to lead to bony union, and the remarkable rigidity and immobility which result from the agglutinated or contracted extra-articular structures—fasciæ, muscles, and ligaments—especially when dense, fibrous, deeply-extending cicatrices co-exist, favoured the supposition of the common prevalence of true bony, irremediable anchylosis. We know that absolute bony union of articular surfaces is a comparative rarity, even in pathological cabinets.

For practical purposes we may divide the conditions in which joints contracted from disease are presented to the surgeon, with a view to the restoration of form and motion, into three classes. 1st. Those in which the resistance to motion is furnished solely or mainly by the extra-articular tissues. 2nd. Those in which, in addition, more or less considerable changes within the articulation have occurred, viz. transformation of the synovial surface, vascular adhesions, fibrous adhesions, erosion of cartilage or of bone, mineral or bony deposits. 3rd. Absolute osseous anchylosis.

The first class of cases is common. We have met with numerous instances of knee and elbow-joint contraction, induced respectively by severe, deeply-extending burns, by phlegmonous erysipelas, by 'swelled leg,' in which the history of the case, the state of obvious contraction and adhesion of the extra-articular tissues, together with the absence of displacement or deformity of the articular extremities of the bones, left no doubt in our minds that the articular surfaces, notwithstanding the paucity of motion, or its entire absence, were free from organic change. In these cases, restoration of

form, and often an almost complete recovery of spontaneous, *i.e.* voluntary, movement, may be effected without difficulty.

The second class of cases includes some which have had a similar origin to those of the first category, but in which the injury or inflammation has extended to the interior of the joint, or at least has involved the capsular ligament. In these cases, deep, retracted, indented cicatrices, and bands of indurated adventitious tissue, penetrating, it may be presumed, into the hollows and sinuosities of the ends of the bones, even if all happen to be exterior to the articulation, tell of exposure of the synovial membrane so near to the disease, that it is improbable that it will have escaped. These cases admit of rectification of position, and commonly some degree of voluntary motion follows, but not always until months or years after active orthopædic treatment has been discontinued. The bulk of the second class consists of cases resulting from strumous synovitis (?) and diseases of the articular extremities, rheumatic and gouty contractions, and distortions from accidental violence.

The strumous distortions of the knee usually present considerable mobility within a limited range, with much deformity and prominence of the internal condyle from subluxation and from wasting of the member above and below the articulation. They are usually straightened without difficulty, although much prominence of the condyles and subluxation will remain. Partial mobility is usually recovered.

The rheumatic cases which apply for orthopædic relief are principally of two kinds, those in which 'chronic rheumatic arthritis' subsists, and those rarer instances of acute articular inflammation excited by exposure to cold during gonorrhœa, childbed, or an early stage of lactation. In the first kind, during the comparatively early stage, much intra-articular fluid secretion and free mobility within a certain range remain. At a later stage, in proportion to the development of gelatinous and vascular adhesions and mineral deposit, the movement becomes more limited. Before and subsequently to the appearance of Bonnet's work, *Thérapeutique des Maladies Articulaires*, we have been accustomed to attempt, by gentle manipulations and gentle but firm employment of mechanical contrivances, to restore these limbs to greater usefulness as regards movement and symmetry. We have succeeded in obtaining the latter, but not the former desideratum. In fact,

as might be inferred from correct pathological knowledge, the benefit of orthopædic treatment is in the inverse proportion to the anatomical degeneration which the rheumatic joint has undergone.

In the second kind of rheumatic cases of partial anchylosis, those which have commenced with very acute affection of one joint, most often the knee, the loss of motion occurs rapidly, and is frequently complete. It seems, in these cases, that an acute destruction of the synovial surface, with rapid exudation of mortar-like plastic material, takes place, causing firm agglutination of the ends of the bones.

Tact in the examination will usually show that absolute immobility of the knee, from whatever cause the anchylosis has proceeded, does not exist. The surgeon can with certainty determine that the joint is movable if an energetic effort to bend or straighten the limb produces a sharp pain through it. We may deduce some favourable conclusions as to the state of the joint if we find the patella movable. This bone may sometimes be moved upon its perpendicular axis when no motion is perceived upon the horizontal one, and when no flexion or extension of the knee can be effected by ordinary handling of the joint.

We make no other mention of stiffness of joints from common articular rheumatism, acute and chronic, than to observe, that as this affection usually leaves the synovial membrane intact, no deformity, as a rule, remains, the exception being in the ankle; here the weight of the body comes more mischievously into play than elsewhere, and sometimes gives rise to a rheumatic in-ankle or flat-foot.

Many rheumatic contractions, those which are the least amenable to treatment, belong to the peculiar form of the disease denominated 'chronic rheumatic arthritis' by Adams of Dublin, the 'rheumatoid arthritis' of Garrod.

As a rule, in reference to orthopædic treatment, a correct judgment of the condition of a joint contracted from disease may be formed from the history and the external appearance, aided by careful manual examination. In the hip, the diagnosis is sometimes more difficult, because the history communicated may be fallacious in consequence of the greater liability to errors in diagnosis during the first stage of disorder in and around this articulation. Thus we have seen hip-contractions in which the primary hip-affection had been originally sciatica,

muscular and fascial rheumatism of the bulk of muscles of the hip and loin, or one of the forms of rheumatism of the joint itself, or 'morbus coxæ,' or the result of accident. To these causes of hip-contraction, which are not always diagnosed, we may add the peculiarly grave intra- and extra-articular exudation which occasionally occurs at the close of malignant scarlatina, and the less serious persistent drawing up of the thighs which occurs (without pyæmia) during a tedious confinement to bed from fevers and phlegmasiæ, especially in persons whose growth is not complete. We have also met with severe rigid hip-contraction, with pain and wasting, which had commenced during pregnancy from uterine influences; also after childbirth from puerperal disturbance; and in unimpregnated, as well as in unmarried women, even from great fæcal accumulation in the intestines. Whilst reminding the surgeon of the various causes of persistent hip-contraction, we may complete the list by adding congenital contractions and luxations, paralytic and spasmodic contractures, some of these being hysterical, and some very grave affections, proceeding from disease of the brain or spinal cord, sometimes co-existing with angular spinal curvature. We have not enumerated these numerous causes of hip-contraction, as if they were so many pitfalls to the surgeon; but in order that, knowing what may have produced a given contraction, the young surgeon may be forearmed for diagnosis and successful treatment.

Treatment of partial and complete ankylosis.—The several forms of contracted joints of the extremities above enumerated admit of three modes of treatment: 1st. Mechanical extension, including manipulations and shampooing. 2nd. Tenotomy, succeeded by gentle, gradual mechanical extension. 3rd. Violent extension under the anæsthetic influence of chloroform, sometimes preceded by tenotomy.

The majority of joints affected with incomplete ankylosis, even the knee, elbow, or hip, still more the smaller articulations, and even after three or four years' duration of the contraction, admit of as full and prompt restoration by gradual, gentle employment of mechanical extension as by either of the remaining modes of treatment above indicated, with the advantage of the treatment being conducted without pain, suffering of any kind, or confinement to the house. In severe knee cases of many years' duration, subcutaneous division of the hamstring muscles may advantageously precede the mechanical

treatment, the surgeon bearing in mind that here, as in other distortions, success depends more upon the manner in which the mechanical treatment is conducted than upon operative interference. In a small proportion of cases, those in which apparent total immobility exists, or in which it is obvious that partial calcareous deposit has taken place, violent extension, with the aid of chloroform or ether, may be employed. We annex a few detailed observations on the mode of conducting each of these processes.

Mechanical extension of partially anchylosed joints.—Long experience in the use of mechanical apparatus shows how little actual apparent power is required to overcome the most rigid contractures of joints. The first condition of success is the correct adaptation of the appropriate apparatus to the size and natural movements of the part. It is of much importance also, that, when practicable, the apparatus should only limit the movement of the affected joint towards the contracted side, *i.e.* it should not immovably fix the part in every direction, but should leave some 'play' to the limb in the direction which it is wished the part should take. No curable anchylosis, free from bony union, can resist gradual, gentle pressure; we only resort to tenotomy, in addition to mechanical extension, for the purpose of saving time. A little consideration will explain how apparently slight continued pressure can effect so great a result as the straightening of a knee contracted for twenty years from former articular disease or injury. The uninitiated surgeon is accustomed to regard such a joint as 'nearly anchylosed;' perhaps he does not reflect that, if bony union have not taken place, the opposing structures are 'soft parts,' *i.e.* shortened muscles, ligaments, fasciæ, cutaneous textures, and cicatrices, all liable to yield to steady pressure. It is probable that as soon as this gentle pressure is applied, the contracted muscles, shortened merely from position and repose, *not being spasmodically affected*, resist elongation, but they speedily tire, and give up the unequal struggle; the non-muscular parts, however dense they may be, probably undergo some change of vascularity, some interstitial change in their nutrition as a consequence of the *gentle violence* they undergo, through which their mechanical power of resistance is diminished. An increase of temperature and of bulk of the part undergoing mechanical extension is usually perceived, which we believe to be due to increased flow of blood consequent upon the stimulus

of the state of tension in which the resisting tissues are maintained. This augmented flow of blood is unaccompanied by inflammation or even by pain when the part is at rest. Such appears to be the process in the structures on the contracted side of the member. The treatment probably receives aid from the muscles on the uncontracted side. The direction of the distortion was originally determined by the stronger set of muscles, or by those most advantageously situated, having overpowered the weaker set. When the contracted muscles yield in their turn to the mechanical instrument, the muscles situated on the uncontracted side tend to recover their lost sphere of action, and assist replacement.

The knee-joint, being a simple hinge, while the thigh and leg each offers a great length of leverage, is advantageously formed for successful orthopædic treatment by mechanical extension; and consequently we meet with no partially ankylosed knee which cannot be straightened and rendered fit for use without the aid of tenotomy or chloroform in a period varying from one to three months.

The anatomical relations of the hip-joint render it less favourable for orthopædic treatment than any of the ginglymoid articulations. At the hip, the shortness of the lever afforded by the small depth of the pelvis, and the difficulty of fixing the pelvis, explains why, when power is applied to the thigh with the view of extending the abnormally flexed or contracted hip, the lower part of the vertebral column, back, and loins, yield anteriorly, causing an extreme hollow in the loins (lordosis). In fact a small part only of the power employed is effective on the contracted hip-joint, the greater part being expended in dragging forwards the lowest dorsal and the lumbar vertebræ. We may mention, in illustration of the comparative difficulty of straightening the hip, that in an instance of uniform fibrous and vascular membranous adhesion of the head of the femur within the acetabulum after death, the partially ankylosed pelvis and thigh having been removed from the body, we were unable to extend the hip by any power we could exert with our hands, until the capsular ligament and some of the adhesions within the acetabulum had been severed with the knife. The same kind of adhesions in a knee would have yielded to the power fruitlessly employed at the hip.

Great ingenuity has been displayed in the manufacture of the apparatus. Occasionally considerable demands upon the

skill of the mechanist are required. The continued attention of orthopædic practitioners who, during the last five-and-twenty years, have trodden in the footsteps of Scarpa and Stromeyer, bringing pathological and anatomical knowledge, with experience, to the aid of the instrument-maker, has revolutionised, simplified, and thus far perfected orthopædic apparatus. As a general rule, elaborate instruments should be avoided. They are often strictly articles of luxury, not obtainable for the treatment of the majority of cases that present themselves in private, and especially in public, practice. We may affirm that when *nothing* can be effected for the relief of a deformity without a complicated instrument, very little can be effected with its assistance. Yet in numerous instances, as in congenital club-foot of adolescents, in considerable knee-contractions, and subluxation, the necessity of well fixing one part whilst another is acted upon, or the complicated character of the deformity itself, entails corresponding need of an elaborate contrivance.

Different mechanical forces are employed—the lever, the screw, and the spring; the last two often resolvable into the lever, screws and springs being employed to modify the action of the lever. The discussion of the relative advantage of the different modes of applying these forces would lead us away from our immediate object.

It should be borne in mind during the employment of these forces in orthopædic apparatus, and especially in the use of the screw, that it is available less as a means of abruptly forcing the deformed parts into their natural position than as an adjusting contrivance. In any case in which the screw is *forcibly* employed, unless for a very brief period, excoriation, sloughing, or intolerable pain, will inevitably result. In some *patient* individuals, vesication, and even superficial sloughs, may be induced over projecting bones without complaint of pain—an urgent reason for anxious examination of a part subjected to pressure, especially by the inexperienced orthopædist. Large sloughs are more than inexcusable.

Every apparatus should be padded, so as to avoid pressure upon prominent points of the bone, and adapted to each individual case. The orthopædic apparatus, like that for a fractured limb, should compress the part in its circumference as little as possible, and never tightly encircle it. It should act gradually, *in proportion as the deformity itself changes its form.*

We have endeavoured in our previous remarks to show, that if a contracted member,* a knee for example, is evenly secured in a suitable apparatus, accurately adapted to the degree of bending of the joint, the processes which ensue in the joint when a moderate tension is imparted soon favour the moving of the joint in the direction contrary to that which it may have long maintained. A contracted knee resting upon its posterior aspect in an apparatus, tends by its own weight to regain a straighter position.

At the outset, the surgeon should be content simply to apply the instrument to the deformity, and not to apply the deformity to the instrument, as is too often attempted by novices in orthopædic practice. In this gentle manner of proceeding, the first difficulty in the treatment of every case of deformity is overcome,—the patient suffers nothing from the attempt to straighten the part; the simple inconvenience of wearing an apparatus, the irksomeness attendant upon necessary confinement of the affected part in an unfamiliar instrument, is his only trouble, and one which is speedily, in a day or two, overcome. Having once applied a well-fitting instrument, the screws or straps by which it is adjusted to the now improving member require to be advanced or tightened as opportunity offers. An impatient advance of the pressure will, by production of pain, and necessity for relaxation of the instrument, occasion loss of time. The principle of action in the progress of mechanical treatment should be that of never advancing too rapidly, so as to risk the necessity of receding. By gentle means, and uniform steady advance, the patient's confidence, so essential to prompt recovery, remains undiminished. By subjecting the member to no greater pressure than can be easily borne, no temptation to loosening the apparatus is afforded to the timid, and no risk is incurred of occasioning excoriation or inflammation in individuals possessing greater endurance, or in young children, whose cries may be attributed to other causes. In this manner, in suitable cases, the opposition offered to restoration by fasciæ, tendons, ligaments, and ill direction of articular surfaces, apparently irresistible, may, with the further aid of manipulations, be removed.

* The greater number of contracted joints, when not affected with bony ankylosis, if left to themselves, may be regarded as contracting joints; for the contracting process is ever progressing until it attains the maximum.

In the choice of mechanical apparatus the surgeon should also be guided by that principle which actuates him in the selection of therapeutic agents in any internal or external disease, viz. the use of that means the action of which he best understands, or in the use of which he has had most experience. A common splint, properly applied, will effect more benefit than an instrument of greater pretension indifferently managed.

From all these considerations, it is apparent that much harm will result, in the great majority of deformities, from the habit sometimes pursued of keeping a deformed part many weeks in succession in an apparatus without the removal so necessary for the purposes of cleanliness, manipulations, and readjustment. Among the evil consequences of too long retention of instruments, often combined with unsuspected excessive pressure, the author has witnessed the production of an opposite kind of deformity, as the conversion of varus into valgus, and a degree of rigidity of the part, which has required weeks of painful manipulations and stretchings, before the natural movements have been possible—sometimes, indeed, restoration of motion of an articulation has been rendered impossible.

The slighter the deformity, the more necessary is frequent removal of the apparatus, because by removal and appropriate manipulations we insure retention of mobility. In severe cases, in which we expect only to effect straightening, and do not anticipate restoration of mobility, frequent removal of the apparatus is unnecessary; for too frequent removal may be hurtful, by allowing the recently elongated tissues to recontract during the time the apparatus is removed from the part.

Division of the hamstring muscles.—We have shown that in a limited number of knee-contractions from disease and accident, section of the hamstring muscles may be required as a preliminary to gradual mechanical extension, or to abrupt violent extension under chloroform. In all cases after tenotomy, extension, whether gradual or abrupt, should be delayed until the healing of the punctures in the integuments. In the knee this healing is seldom complete until four or five days after the operation. The following rules may be given for severing the hamstring tendons: Place the patient in the prone position, and let an assistant make firm extension upon the joint, or desire the patient to endeavour to bend the knee, by either of which means the tendons will be rendered prominent. In general

follow the directions laid down for the division of the tendo Achillis (p. 676). In severing the tendon of the biceps femoris, insert the tenotome in the adult an inch above the apparent point of contact of the tendon with the fibula, remembering the proximity of the external popliteal nerve, and keeping, therefore, the tenotome close to the tendon. The semi-tendinosus being very superficial is readily severed by a puncture, where it springs up most prominently; the semi-membranosus being more bulky and fleshy, as well as more deeply seated, requires a larger sweep of the end of the tenotome. It is scarcely necessary to recommend caution as to the important nervous, arterial, and venous structures of the popliteal region. After section of the inner hamstrings, the pressure of the assistant's hands upon the limb being continued, bands of fascia and nerves make themselves prominently felt in the ham. Troublesome numbness in the calf, and unusual pain during extension, has followed the unnecessary division of these structures. It is desirable to apply promptly a pledget of lint and suitable pressure by a bandage over the punctures, to prevent oozing of blood into the areolar tissue of the ham, which affords an inconvenient nidus for suppuration. By adopting this immediate covering and pressure over the puncture, we have never witnessed delay in healing beyond four or five days, in ordinary moderate temperature. Very cold weather may cause tenotomy punctures in limbs of weak circulation to appear, at the end of several days, as if they had been effected an hour previously, no attempt at adhesion being made. It is therefore proper in cold weather to envelop the limb in flannel, and assist the reparative powers of the patient by generous diet.

Forcible subcutaneous separation of the tibia and femur in true bony ankylosis of the knee-joint.—This operation, originally proposed and carried out successfully by Langenbeck and Gross of Philadelphia, has been performed in this country with some modifications by Mr. Little at the London Hospital. The operation consists in making a small incision in the integuments and fibrous tissues at the side of the articulation, parallel to the plane of the natural articulating surface of the tibia. The length of this incision should correspond with the width of a narrow sharp-cutting, well-tempered ordinary chisel, say two to three lines in width, which being driven in different directions between the ends of the femur and tibia, united by osseous

material, so effectually weakens the connection between the adherent surfaces, that straightening and bending of the limb can, with the exercise of 'gentle violence' with the hands, be readily effected. When the surgeon remembers that the *joint* has been destroyed by the diseased process which produced the bony ankylosis, he will not be surprised to learn that this surgical subcutaneous chiselling asunder of bones is not followed by any of the serious consequences known to follow wounds of the joint, and that with or without simultaneous section of knee tendons, as may appear requisite, the limb may be placed in the desired curative position. It may seem superfluous to remark that the operation is perfectly safe in the hands of the surgeon who avoids injury of the important nerves and vessels about the articulation. It cannot fail to become a standard operation for relief of knees affected with *bony* ankylosis in a bent position, and is in every respect infinitely preferable to the operation of knee resection when it has been performed for mere ankylosis.

Division of muscles in the vicinity of the hip-joint.—Though in hip-contractions the majority of the muscles proceeding from the pelvis on the flexed side of the part are contracted, experience teaches that few require operative interference. We have many times severed the origins of the adductor longus, adductor brevis, and pectineus, the tensor vaginæ femoris, and the superior origin of the rectus femoris. But of late years we have commonly restricted the operation to the tendon of the adductor longus, for the relief of tense abnormal approximation of the thighs, in cases of general spastic rigidity of the lower extremities. The adductor longus, from its position, exerts a relatively greater influence in morbidly adducting the thighs than other muscles. Its division is a satisfactory starting point for subsequent benefit from manipulation and use. It is effected according to the general principles of tenotomy, and requires no particular description.

Section of the tensor vaginæ femoris and rectus is suggested in certain cases of paralytic contracture of the hip, in which atony of the adductors of the thigh exists, a state of things opposite to the last-mentioned kind of case. Here the thigh is drawn from its fellow, the trunk tending to fall to the ground, as it were, between the thighs. Where contraction of these muscles exists, the paralysis of the adductors and other muscles of the hip (*psoæ* and *glutei*) is usually so considerable, that little

radical good results from the operation. It should, therefore, as a rule, be superseded by manipulations, frictions, and mechanical appliances.

Division of the flexor tendons of the fingers and toes.—The phalanges, when contracted from articular complaints, require treatment similar to that of the larger articulations. Commonly it is the flexor tendon which is implicated. Enough has been stated concerning the large ginglymoid articulations to render many details of treatment of these small articulations unnecessary. In operating on the fingers, we have to consider beforehand whether the articular disease has left the joint in a condition to resume its function as to movement; for if we may not expect to recover mobility, a straightened finger is not preferable to one partly bent. We require also to calculate the chance of the tendon when operated on in the course of the theca becoming agglutinated to the theca, and the finger subsequently on that account not regaining movement. In the foot, the most frequent affections of the toes for which surgeons are consulted are those resulting from improper shoes worn during the growing period of the foot—in childhood and adolescence. The great toe is often thrust inwardly, and overlaps the next toe, the metatarso-phalangeal articulation being inflamed and ultimately deteriorated as to the normal condition of the articular surface, with consequent impairment of mobility and very troublesome lameness. The joint is inclined to stiffen in the extended position after subsidence of the irritation or inflammation, the individual being prevented standing tip-toe, or ascending a hill without pain or inconvenience. This condition of things may, before and about puberty, be remedied by rest and suitable topical applications, followed by manipulations; the interposition of a partition between the toes, so as to keep the great toe in a proper line with the margin of the foot; and the temporary use of a suitably wide shoe. In long-standing cases, in which the extensor tendon of the great toe becomes rigidly contracted and structurally shortened, and has become dragged outwardly away from its normal situation above and parallel to the metatarso-phalangeal articulation, the section of this tendon may afford relief.

Another common troublesome defect in the toes, similarly produced, though sometimes hereditary, is fixed flexion of the second toe. In children under the age of ten or twelve years,

this defect can usually be remedied by light gentle bandaging (not tight) of the part, upon a padded whalebone splint, night and day, for a few weeks. In older subjects, and in peculiarly rigid cases, section of the flexor tendon, opposite the first phalanx, followed by bandaging on the splint, is a prompt and certain means of cure.

The little toe is often extended upon the metatarsus, or thrust laterally and inwardly and sufficiently prominent to become continually a source of pain and irritation from the shoe. This also is often a congenital affection. Division of the extensor tendon and bandaging affords relief.

The toes, and particularly the great toe, are often contracted in cases of varus, congenital and acquired. These contractions are relieved by the means taken to cure the talipes, and sometimes by gradually improving their position with suitable bandages.

Forcible extension.—Under the head of *manipulations* and stretchings, the value of *gentle* employment of pressure and movements with the hands (passive exercise), both as a means of curing slight deformities, and as an important auxiliary to other methods of treatment, has been shown. If a larger measure of pressure or force be used with the hands, the treatment becomes that denominated *violent extension*. Here, as elsewhere, it is difficult to draw an arbitrary line, and say where gentle manipulation ends, and violent extension begins. In the practice of manipulations, the competent operator may frequently avail himself of the smaller degree of sensitiveness displayed by some patients, or of the momentary abstraction of the patient's volition from the muscles (a circumstance instantly felt by the hand of the operator), and apply an amount of force which approximates to, or may be considered as, violent extension. But *violent* extension with the hands is rarely efficacious in the removal of considerable contraction and deformity, especially in full-grown persons, because either the pain produced is intolerable, or the voluntary resistance offered by the muscles of the patient exceeds that at the command of the operator; a struggle is maintained between the patient's muscles and the surgeon or rubber, in which the latter is commonly not victorious.

Through the inability of one person to effect, with any effort of his will, an extension forcible enough to overcome severe

contraction, violent *sudden* extension, by means of the combined strength of several assistants, or by means of powerful screws, brought suddenly into action, was proposed and carried out, with varying success and misfortune, by Louvrier, Dieffenbach, and others. In the less severe cases of deformity, those indeed which are curable by gentler means, without longer duration of treatment, the parts were *suddenly* straightened by violent extension, without ultimately mischievous results, and the expected benefit was obtained. But in severer cases of deformity of many years' existence, in which organic changes of greater magnitude had taken place, as in severe knee-ankylosis from extensive suppuration about the articulation, with necrosis, the violent separation of adhesions, and snapping asunder of bony deposits in the popliteal space and elsewhere, were accompanied with laceration of blood-vessels and nerves, fractures of the bones themselves, and consequent inflammation, suppuration, and even mortification, of the member. The plan was deservedly denounced, and fell into disuse.

Forcible extension under chloroform.—Surgery received an invaluable addition to its means of usefulness by the discovery of the anæsthetic properties of ether and chloroform; and orthopædic practitioners, following the example of Langenbeck,* promptly availed themselves of the assistance these means are calculated to render in the cure of deformities. Hence the employment of forcible extension with the aid of chloroform or ether. By chloroformisation, the two great obstacles to the employment of force adequate to straighten or bend a contracted limb, namely, pain and voluntary muscular resistance, are removed. As soon as these impediments disappear, the hands of the single operator, and his single mind, applied to the parts, encounter the physical resistance only of the deformed parts; comparatively gentle manipulations now acquaint him with the nature and amount of difficulty; he can feel his way in the application of greater force; can feel and perceive the resistance of parts successfully overcome, in an anatomical order; if greater rigidity still oppose, a few movements of the joint backwards and forwards prepare the way for a more extensive yielding; and often the practitioner has the satisfaction of being able thus to effect every natural movement of the joint.

* *Commentatio de Contractura et Ankylosi Genu, nova methodo violentæ extensionis ope sanandis.* Berolini, 1850.

Chloroformisation, with manipulations, and the use of a certain degree of force, may be of service as a means of diagnosis. By it the practitioner is enabled, in some degree, to ascertain what proportion of the deformity is due to shortening of soft parts, how much mischief the articular surfaces have undergone, and what amount of restoration is practicable.

After straightening or bending the limb, as the case may have required, by means of this forcible procedure, the part should be lightly secured in a retentive instrument or upon a common splint, adjusted so as to maintain a position more favourable than that in which the limb was before the operation, though not so as to keep it in the new position, *i.e.* the entirely straight or bent position into which the hands of the surgeon may have brought it. For as soon as the effect of the chloroform disappears, the patient arouses to the conviction of the violence which may have been employed, the part may be acutely painful, and incapable of sustaining the pressure of a tight bandage or ligature.

We usually content ourselves with the increased knowledge obtained of the nature of the case, with the satisfaction of knowing that the part can be improved in form and function, and as the resisting parts have once yielded, that they will afterwards oppose less resistance to replacement; whether the means subsequently employed should be simple manipulations, the use of mechanical apparatus, or repeated administrations of chloroform, and forcible extension. The surgeon who should attempt the forcible binding down of a long-deformed limb immediately after forcible extension, would betray a lamentable ignorance of the pathological condition of the parts in the immediate vicinity and within the diseased articulation. Although the muscular structures may have yielded under chloroform, and indurated fasciæ and old adhesions may have been overcome by stretching and tearing, it will be remembered that much adaptation on the part of nerves, blood-vessels, and absorbents to the altered position of the structures, needs to be accomplished. We find that, by taking moderate means of retaining as much improvement after the forcible extension as can be borne by the sufferer, by the unsparing use of lotions of spirit or by ice applications, and by the internal use of morphia, dangerous inflammation of joints thus straightened has been averted. By employing afterwards the ordinary means of gradual extension, we have straightened joints which would

otherwise have required many months of ordinary treatment.

It is perhaps not superfluous to remark, that the use of forcible extension is less defensible in cases of recent disease of articulations than even other active attempts to restore the form in such cases. In a diseased joint the practitioner has to note not only the local disorder, but also the general condition, of which the local affection is but one manifestation. When the surgeon, with ability and experience, has cured the local disorder, *i.e.* removed the inflammation, healed the ulcerated or suppurating parts, or effected subsidence of pain, heat, and tumefaction, the consequences of the diseased action, contracture and rigidity only remaining, he has not necessarily cured, by internal and general therapeutic measures, the morbid constitutional state. This often slumbers after subsidence of the local disease; and he should pause ere he too hastily undertakes the restoration of form and movements by forcible extension under chloroform, or by other active measures, and thus incautiously evokes a renewal of local disorder.

These views were enunciated* some years ago by the author perhaps with more leaning to the employment of forcible extension. It will be found that violent extension is necessary in a relatively small number of cases, provided gentler means are suitably carried out. Orthopædy is capable of curing all those contractions in which the innervation is not hopelessly disturbed (severe paralysis and spasm), and those in which the synovial surfaces, cartilages, and articular extremities of the bones are not disorganised from disease. When we cannot hope to do more than straighten the limb, as in long-standing hip and knee contractions from articular diseases, violent extension under chloroform is most opportune as a means of obtaining a more useful position of the member.

The expectations of surgeons some years ago of the benefit likely to result from operative interference in cases of partial hip ankylosis, so as to produce a new or artificial joint, have not been verified. Excision of the head of the femur, owing to inability to deal effectually with co-existent disease of the acetabulum, has been less successful than elsewhere. In long-standing hip ankylosis, be it false or true, if we should be unable to straighten the member by gradual mechanical treatment,

* *Treatise on Deformities of the Human Frame.* 1853.

or by forcible manipulation under chloroform, there is one resource available, that of severing the bone by subcutaneously sawing or drilling it, below the trochanter, where it most nearly approaches the surface.

In a few cases at the other extremity of the pathological scale, in which the will alone, or timidity, or the peculiar abnormal state of the system exists which is met with occasionally in young persons of both sexes, in whom in consequence of slight injury, a limb remains stiff in the straight or bent position (emotional or ideal paralysis), the part is relaxed under chloroformisation, and the contracture is often by this means promptly and permanently cured. True hysterical contractures yield with equal facility during the anæsthetic state: but they usually return when the effect of the chloroform has passed off. In some of the severest hysterical cases which the author has met with, recovery has taken place after the lapse of a few months, or a year or two, either spontaneously, or from the effect of altered dietetic, social, or climatic influences.

W. J. LITTLE.

DISEASES OF THE BONES.

DISEASES of the bones may be conveniently divided into the following classes:—*First*, inflammation and its consequences: under which head it is proposed to include the varieties of the inflammatory process, which have received the names of periostitis, osteitis, and osteo-myelitis; and, as consequences of these, all the numerous conditions which have been confounded together under the common but vague designation of caries, the various forms of suppuration in bone, the varieties of necrosis, its effects, and those processes of repair which result in permanent modification of the structure and form of the organ. The *second* class will include the specific diseases, which occur either as modifications of the inflammatory process—syphilis, scrofula, and rheumatism in bone—or as constitutional conditions leading to changes in the bony structure; such are, mollities ossium, rickets,* and cancer. The *third* division will comprise a description of the various new formations found in the osseous system, and which are not dependent on any of the known constitutional cachexiæ. The *fourth* will treat of atrophy and hypertrophy properly so called, *i.e.* uncomplicated by inflammation.

SIMPLE INFLAMMATION AND ITS CONSEQUENCES.

Inflammation of bone differs from inflammation of soft parts, not in its essential, but in its accidental features; the inflammatory process is the same, but the conditions or circumstances are different, and hence arise diversities in rate of progress, in external appearance, and in other symptoms; diversities which, although they are not really essential, yet cause striking dif-

* The subject of Rickets, however, will not be found here, as it has been thought better to refer it to the SURGERY OF CHILDHOOD.

ferences to ordinary observation, and have led to the designation of the results of inflammation in bone by names differing from those which are used for the same changes in soft parts. This difference in nomenclature, though it might arise in mistake, at a time when necrosis was thought to be something essentially different from gangrene, and carries a disease which had little in common with ulceration, is yet hardly to be regretted, since the diseases of bone, though pathologically identical, are practically very different from those of soft parts; and it is convenient to have separate names for things which require very different treatment, and entail a very different amount of danger.

If the reader will consult the appendix to the essay on INFLAMMATION at the end of this work, he will find abundant information on the early steps of that process. These affections are identical in bone and in soft parts; in fact, they can occur only in the soft parts of bones, since the mere inorganic matter, which, involved in the convolutions of a cellulo-fibrous and vascular network, constitutes a bone, can itself be the seat of no vital actions, but must obey the movements impressed upon it by the living textures around.

In Von Bibra's essay *On the Decomposition of Bone by Caries*,* will be found a good deal of interesting information on the chemical and microscopical characters of bone in inflammation; and from this author's researches it appears clear, that the changes in the inorganic constituents of bone are often limited to the dissolution of that connection which previously united them to the organic matrix, so as to form one system. This connection having been severed, portions of the salts are washed away in the discharges, and they may be found, according to Von Bibra's account, in unaltered chemical composition, while the composition of the organic constituents of the same part is profoundly changed, principally by that fatty degeneration which occurs in all inflammations. The inorganic constituents must, however, in some cases of inflammation undergo other changes, since they may disappear in large masses, without any discharge having been present. Thus in caries of the spine, or in inflammation excited by the pressure of tumours, it is not rare to find that large portions of the vertebral column

* *Liebig und Wohler's Annalen*, vol. lvii. It will be found useful to compare this essay with those of Mr. Barwell and Dr. Black, referred to farther on.

have been removed, sometimes to such an extent as to expose the spinal canal; yet no abscess has formed. The older pathologists made a distinction between these cases and those of caries, founded on the presence of pus in the latter, and its absence in the former; but this distinction, though of great practical importance, does not indicate any pathological difference. Both are inflammatory processes, though of different degrees: the one, ulceration attended by suppuration; the other, ulceration attended by liquefaction only. From this fact of the disappearance of masses of hard tissue, without any discharge in which they can have been washed away, it seems clear that the small earthy particles thus loosed from their natural connection with the organic matrix may undergo a reversal of the process by which they were deposited out of the fluid blood; *i.e.* may become again soluble, and pass into the venous current.

The earliest microscopical change* is an unusual fulness and distinctness of all the vascular cavities of the bone; the Haversian canals, lacunæ, and canaliculi being all more sharply marked than in the natural state. This Von Bibra compares to the injected condition of soft parts. Later on, the Haversian canals and lacunæ become widened; the latter disappear in consequence of the communication of neighbouring cavities, and spaces are formed in the bone, filled with fat and earthy salts, the detritus of the decomposed tissue.

The earliest change in the consistence of bone, produced by inflammation, appears to be softening; as a consequence of the loosening and absorption of the mineral portion, and the liquefaction and conversion into fat of the organic matrix. Mr. Barwell has published an interesting essay 'On Osteitis,'† which affords, perhaps, the most distinct demonstration of the enlargement of the vascular spaces at an early period of inflammation. In this essay, Mr. Barwell teaches that the earliest stages of inflammation are accompanied by induration; an assertion which I venture to question, since it appears to me that induration is a phenomenon subsequent in order to the inflammatory process in its stricter sense, and due to one of its results, *viz.* effusion. The reader is referred to the original essay, which will well repay perusal.

* See Von Bibra, *op. cit.*

† *Brit. and For. Med.-Chir. Rev.* April 1860, pp. 460 et seqq.

Such are the earliest changes in the minute structure and consistence of inflamed bone. The changes which take place in its rough anatomy may be thus described. If a bone be examined at an early period of inflammation (the ordinary and most accessible instance is the stump of the bone in an amputation fatal, say, three weeks after the operation),* the periosteum will be found somewhat thickened, vascular, and not so closely connected to the bone as usual.† If the periosteum be stripped off, the bone is seen to be irregularly vascular, some portions of it having a slightly red tint, and contrasting with the healthy white colour of the rest of the bone. This red tint is evidently caused by the enlargement of the vessels which pass from the periosteum into the bone; and if a magnifying-glass be used, the increased size of the vascular apertures is easily proved, while if pressure be made on the surface of the bone, drops of blood will frequently ooze from the mouths of the enlarged vessels, proving their increase in size, as well as the loss of consistence in the outer hard wall of the bone. At the same time there will be found, in all probability, on some other part of the surface, more or less deposit of osseous matter, which, with the partial separation of the periosteum above mentioned, testifies to the fact of effusion from the vessels of that membrane. In these simple cases of injury the deeper parts of the bone will probably be unaffected; but should this not be the case, *i.e.* should inflammation have also attacked the membrane lining the medullary cavity and cancelli, that membrane will be found in a condition essentially analogous to that of the periosteum, although the different situation of the medullary membrane, and the great quantity of fat and other loose tissues among which its vessels run, will somewhat modify the external appearances. If, however, these appearances be minutely investigated, they will be reduced to, increase in the number and size of the vessels, and effusion of blood, lymph, or pus, according to circumstances. The thickening both of the perios-

* In such a specimen the periosteum will generally be found stripped off from a small ring at the lower end of the bone, and this part will perhaps be dead or about to die; but as this feature is accidental, it will not be further noticed.

† Hunter has put up (Mus. Coll. of Surg. No. 656) 'A preparation of a femur, which was amputated, with the periosteum separated; to show how clear the periosteum separates from the bones in inflammation; a fact almost always observable after amputation.'

teum and of the medullary membrane is sometimes considerable. The former membrane is, of course, more frequently found thickened than the latter; but preparations showing the participation of the medullary membrane in inflammation of the bone, and the identity of its appearance with that of the thickened periosteum, are not wanting.*

Thus we see that when inflammation commences, as it usually does, on the surface of a bone, whether periosteal or endosteal, its primary symptom is increase in the size (and perhaps number) of the capillary vessels, or vascular spaces, and effusion of blood or lymph. The primary effects of inflammation in the central parts of the compact tissue are similar to the above; though here, from the different circumstances in which the vessels are placed, this similarity has been less distinctly perceived; and from the slowness with which all changes go on in the compact tissue, opportunities rarely occur of comparing the different parts of the same bone with each other. The first change is the enlargement of the vessels which run in the Haversian canals; but effusion is a much later phenomenon, and is preceded by the absorption of the bony tissue which adjoins the enlarged vessels; so that in microscopical sections of inflamed bone, the Haversian spaces are seen much enlarged, irregular, eroded, and sometimes almost, or quite, communicating with each other. The lacunæ may also be noticed to be densely crowded together, and sometimes the granular matrix of the bone appears more coarse than natural. When this absorption of the walls of the Haversian canals becomes visible to the naked eye, the first change in the rough anatomy of inflamed compact tissue becomes appreciable—that in which spaces are seen in it on section like those in cancellous tissue, so that it is sometimes said to become cancellous. Similar changes occur in the cancellous tissue itself, whereby its cells become much enlarged, and sometimes the whole bone is expanded by the simultaneous yielding of its walls.†

Into the spaces thus hollowed out in the substance of the

* One of the most striking preparations of this kind is in the Museum of St. Bartholomew's Hospital—a humerus; series i. 207.

† See a description, by the author, of the bones of the lower extremity ten months after excision of the knee, where the superficial laminae of the femur had been so separated from each other by inflammation that the bone cracked under the pressure of the finger.—*Path. Soc. Trans.* vol. xii. p. 171.

bone, or on its surface, by the removal of the earthy matter, the products of inflammation are next secreted. These secretions vary, of course, according to numerous preceding circumstances, *e.g.* the nature of the injury, or other cause of inflammation, the activity of the process, the constitutional condition of the patient, and a thousand others; and so the products of ostitis are divisible into two principal varieties, corresponding to the plastic and aplastic lymph met with in other parts, and leading, the former to the deposition of earthy matter and the formation of new bone, and the latter to suppuration. The former result terminates in hardening, or *sclerosis*, as it is termed; the latter in a variety of conditions: when the suppuration is limited within a cavity in the cancellous tissue, or in the compact tissue rarefied by previous inflammation, *circumscribed abscess* is produced; when the pus extends along the inner surface of the membrane lining the medullary cavity and cancelli, the condition of bone exists which is now usually spoken of as '*osteo-myelitis*,' and which used to be called 'diffused suppuration in bone;' suppuration between the periosteum and bone forms *periosteal abscess*, acute or chronic; and any of these forms of suppuration, when accompanied by the insensible exfoliation of the bone (or its death, and removal in invisible portions), constitutes ulceration of the bone, or *caries*. Lastly, inflammation of the bone sometimes leads to the death of larger portions of its tissue, which are then removed by the process of ulceration, as in soft parts. This constitutes gangrene of bone, or *necrosis*; but as that condition, like other forms of gangrene, is often produced by other causes not inflammatory, the whole subject of necrosis must be treated by itself.

We have now to consider separately the causes, symptoms, and treatment of each of these phases of the inflammatory process; the above being intended only as a kind of ground plan, to mark out the various parts of a rather intricate subject, each of which must be studied in detail.

Ostitis.—Inflammation of bone is excited usually by external violence, or exposure to cold, acting upon a constitution predisposed to the disease. The chief predisposing causes are, the syphilitic or scrofulous taint, rheumatism, and defective nutrition; or these may themselves set up inflammation in any bone, without a distinct exciting cause. From this mode of causation it follows, that the bones most liable to inflammation are those

most exposed to the action of external agents. Hence we see it most frequently in the tibia among the long bones, and in the skull, sternum, and ribs among the flat bones. The bones of the foot and hand are also very frequently affected.

Ostitis is a very common affection, although not much recognised; partly because, from the little attention it has received from our older authors, and from the fact that most swellings of bone are regarded as periosteal, we are not much in the habit of looking for it; and partly because its symptoms are at first obscure, and liable to be masked by those of the injury to the soft parts with which it is associated, or of the constitutional affection from which it springs.

The symptoms vary according to the stage of the inflammation. In the first stage, that in which the size of the vessels is increased, and in which absorption is being produced, the disease frequently makes considerable progress without appreciable symptoms.* Sooner or later, however, the occurrence of those characteristic dull pains in the bones, exacerbated by changes of weather, increasing in severity during the night, and somewhat resembling the pains of rheumatism, which are described by French writers as '*douleurs ostéocopes*,' draw the attention of the patient to the seat of the disease, and form a valuable guide to the surgeon. If the part be now examined, the probability is that some evidence will be found of inflammation in the tissues surrounding the bone—*œdema*, redness of the skin, tenderness of the soft parts, or threatening abscess. The absorption of the earthy material, which accompanies this increased vascularity, manifests its effects upon the bone by a diminution in its consistence, and then the bone becomes at the same time increased in volume and diminished in its resistance to pressure. The former symptom is indeed somewhat delusive, since the apparent increase is often due principally to enlargement of the soft parts. Thus, the expansion of the joint-ends of bones, which frequently appears so considerable in chronic affections of the joints, is often reduced to a hardly appreciable enlargement on dissection. But the swelling of the bone may sometimes be made out very clearly, and is then a

* This is true more especially of the earlier stages, but is occasionally observed in all periods of inflammation of bone. Thus large psoas abscesses, connected with extensive erosion of the vertebræ, are found sometimes in patients not of a strumous habit, and who have not been known to present any symptoms of such an affection.

valuable indication of the disease. The softening is not generally of much importance as a diagnostic symptom; it rarely affects the whole thickness of a bone, so as to lead to a change in its form, and, when limited to a portion of the surface, cannot be appreciated by the touch, since the inflamed and irritable condition of the soft parts renders the patient unable to bear the necessary pressure.

A singular change, which sometimes follows inflammation of a long bone, is its elongation. Dr. Humphry has laid much stress upon the consequences of diseased conditions of the epiphysial lines near the ends of long bones, as affecting their subsequent growth.* It is possible that inflammation of this tissue may have led to the elongation of the bone in some of the cases; as in a tibia from a lad aged eighteen, preserved in the Museum of St. Bartholomew's Hospital, in which the bone has become lengthened, and is curved in order to adapt its length to that of the healthy fibula.

To the stage of absorption and rarefaction succeeds that of effusion and deposit, unless the process be arrested, and resolution occur. The various consequences of suppuration enumerated on p. 735 being reserved for subsequent sections, we need now only consider that termination of inflammation of bone in hardening or sclerosis, which corresponds to the inflammatory solidification of parenchymatous organs; and which, when not too extensive, is for practical purposes little less desirable than complete restoration to health. The interstices of the cancellous tissue are filled up at first with lymph, in which ossific matter is afterwards deposited;† and then the bone, which, while actively inflamed, had been less dense than in its healthy condition, as in Fig. 184, becomes hard, heavy, and solid, as in Fig. 185; the medullary canal is narrowed or filled up, and the shaft thickened by deposit from the periosteum. Bones thus affected abound in every pathological collection; and it is easy to trace in them many of the appearances of which an explanation has been attempted above—the large size of

* *Med.-Chir. Trans.* vol. xlv. p. 294.

† An instructive case is related by Mr. T. Smith, in *Path. Soc. Trans.* vol. xviii. p. 218, of an amputation in a case of chronic osteitis of the femur. 'The shaft of the femur was somewhat enlarged, but its texture was greatly condensed and indurated. The cancellous tissue of the lower end of the bone was plentifully infiltrated with lymph in various stages of disintegration, being apparently purulent about the epiphysial line. This lymph was especially abundant towards the articular end of the bone, where it extended up to and beneath the articular cartilage, which latter was in parts removed by ulceration.'

the vascular apertures, the irregular deposit of bone, both in the centre, the substance, and on the surface of the shaft, the contraction of the medullary cavity, and usually the increase in size of the nutrient foramina. It will generally, but not always, be noticed that these changes are limited to the shaft of the bone, when it is the part first affected, and that the articular ends escape. The converse is also usually

FIG. 184.



(From a preparation in the Museum of the Royal College of Surgeons, No. 3085, to illustrate the rarefying stage of osteitis.) The tibia in this case weighed 9 ounces.

FIG. 185.



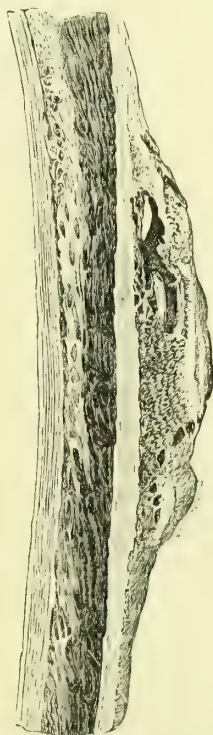
(From a preparation in the Museum of St. George's Hospital, series ii. 19, to illustrate the termination of osteitis in condensation or sclerosis.) The tibia in this case weighed 19 ounces.

the case; though perhaps the shaft is more prone to become involved in the morbid actions of the joint-ends than the joint-ends are in those of the shaft. Thus inflammatory affections may long go on in the shaft of the femur, yet the knee-joint remain unaffected; and, on the other hand, when disease of the joint commences in the articular ends of the bones, the

shafts usually are unaffected, and the disease of the bones considered by itself is not so extensive as to contra-indicate excision. To each of these two general rules, however, numerous exceptions will, unfortunately, be met with in practice.

Inflammation of the bone is almost always known, in common parlance (when it is recognised at all), as *periostitis*; but in truth, periostitis seldom occurs uncomplicated, unless in the

FIG. 186.



Periostitis. (External view.)

FIG. 187.



Periostitis. (Internal view.)

Two drawings from a preparation in St. George's Hospital Museum, to illustrate the ordinary anatomy of periostitis.

course of secondary syphilis;* and almost all the cases which pass under that name are really inflammations, more or less extensive, of the bone. That this is so, will hardly be doubted by any one who considers how few preparations of pure periostitis can be found in our museums, and how seldom, during our

* I would refer the reader to the section on Syphilis in Bone for further details on the subject of chronic periostitis.

post-mortem examinations, we meet with periostitis unattended by inflammatory deposit in the deeper parts of the bone. The symptoms, as well as the morbid anatomy, of both are identical, only that in periostitis the thickening and vascularity involves no other part of the nutrient membrane of the bone except the periosteum, and that the inflammatory deposit is confined to the surface of the bone, between it and the periosteum. Periostitis is a quicker process, and one more under the influence of remedies than the other forms of inflammation of bone; but in all the same general course of treatment is indicated, viz. the internal administration of iodide of potassium, and the local application either of iodine or mercurial ointment, or, in the early stage of the disease, of blisters. These measures should be combined with proper position of the affected member, and as much rest as is consistent with attention to the general health. Leeches or cupping will afford relief if the pain be severe. When there is much tension over the bone, sometimes accompanied (especially in the cranium) with intolerable pain, nothing gives such immediate and decided relief as a free and bold incision down to the bone. The distended periosteum is thus relaxed; and in cases of pure periostitis such a measure may of itself almost suffice for the cure of the disease; but its beneficial effects will be decided, though less striking, in cases of deeper-seated inflammation. In cases of chronic inflammation of bone, accompanied by deep-seated and wearing pain, an opening made with a trephine, for the evacuation of pus, has proved beneficial, even though no pus was found.*

Whether the sclerosis, or induration, which is the final result of chronic inflammation, be amenable to any remedial measures is doubtful, since it usually gives the patient little inconvenience, and therefore is not made the subject of treatment. Thickening over the bone is often left after osteitis, and is often dispersed by the ordinary measures, such as friction and pressure; but the seat of this thickening is very generally in the soft parts around the bone, and not beneath the periosteum.

Diffuse periostitis.—Inflammation of the bony tissue itself is rarely acute, and when it does occur in the acute form passes

* See a case reported by Sir B. Brodie, in his *Lectures on Pathology and Surgery*, p. 410. On the good effects of a free incision of inflamed periosteum, when milder measures fail, see Sir P. Crampton 'On Periostitis,' *Dublin Hospital Reports*, vol. i. p. 331.

rapidly into necrosis, under which head it will be presently spoken of; but acute inflammation between the bone and periosteum, *diffuse periostitis*, is a disease of rather frequent occurrence, and is less noticed in surgical works than its importance would seem to require. It is seen commonly enough in persons about the age of puberty; more frequently in boys than in girls; usually as the result of some injury, and almost always in one of the long bones. It is so destructive in its effects, so rapid in its course, and is so little recognised, that we have unfortunately numerous opportunities of verifying its existence after the time for treatment has passed away; yet to early and vigorous treatment it is tolerably amenable, at least as amenable as so acute a disease can be expected to be.

The pathology of the disease appears to consist in the partial separation of the periosteum from the bone, by effusion on the surface of the latter of lymph, or other products,* soon giving place to a copious formation of pus, which spreads along the whole bone, and dissects away the periosteum from it, often from one end of the bone to the other. If examined at an early period of the disease, the periosteum does not (at least it very often does not) display any distinct signs of inflammation, either in change of colour or of thickness; nor is the surface of the bone visibly inflamed. On the contrary, it usually looks white, and inclined to gangrene, a consummation which rapidly impends over such cases. Sometimes, however, the surface of the bone may be found slightly worm-eaten, and on squeezing it, its superficial layers are found more readily separable from the deeper tissue than in health; large drops of blood can in such

* The disease does not commence by the formation of abscess; often when the swelling and inflammation are considerable, no pus will be found. Of this fact the following is an instance. A lad was suffering from what was supposed to be diffuse cellular inflammation around the ankle after a slight injury. As it was suspected that the inflammation was really subperiosteal, an incision was made down to the tibia. No pus followed. Two days afterwards the boy presented obvious symptoms of confined matter, and now by breaking up the adhesions of the wound a copious evacuation of pus was obtained, and the surface of the bone was felt exposed. A few days later, swelling and tenderness were found over a higher part of the tibia. Thinking that on the former occasion I might not have divided the periosteum freely enough, I now took care to press the edge of the knife firmly against the bone for some distance. Matters went on exactly as in the former wound. No pus was found at the time, but on breaking down adhesions, two days later, with a probe, the pus was discharged, and bone felt exposed.

instances be pressed out of the vessels which pass into the bone from the periosteum. A little later, and necrosis is unmistakably declared, and the whole diaphysis usually perishes, leaving the articular ends unaffected, and therefore not involving the neighbouring joint.

The joint, however, does not always escape. A girl aged fifteen was admitted into hospital four days after an injury, with great swelling of the fore-arm, evidently depending on the formation of matter. A grating sensation, perceived on rotating the hand, together with the history of the accident, led to the belief that fracture had occurred. She died of pyæmia; and then it was discovered that a periosteal abscess, extending from the shaft of the radius into the wrist-joint, had so eroded the articular cartilages as to occasion the sensation of crepitus.

The course of the disease is usually as follows: it commences in the great majority of cases with an injury of more or less severity, occurring to a person generally of the strumous constitution, at any rate a weakly person; the symptoms which immediately follow the injury are usually slight, so that even the occurrence of the accident is perhaps nearly forgotten; then, after a varying lapse of time, probably four or five days, symptoms occur which are almost invariably attributed at first to diffuse cellular inflammation, or to acute rheumatism, viz. rigors, pain in the part, and an œdematous angry swelling. At the outset the diagnosis is not easy; indeed, before suppuration has occurred, perhaps no certain diagnosis can be made. However, as respects diffuse cellular inflammation, the age of the patient, the comparative remoteness of the cause, and the previous immunity of the superficial parts, will lead to a suspicion of the nature of the case, which will be strengthened when the inflammation is seen to be limited to the section of the member first affected, instead of passing the joint, and spreading up the limb, as an erysipelatous affection would in all likelihood do, and will be converted into certainty by the discovery of deep-seated matter, either by fluctuation or on puncture. Fluctuation cannot always be detected, since the tension of the membranes which bind down the pus, and the tenderness of the superficial parts, combine to oppose its discovery. Exploratory punctures, however, should never be neglected. If the disease be merely superficial, they can do no harm; and it is of vital importance to discover early, and give instant exit to, the pus before it has dissected off large portions of the periosteum, and involved the death of a great part of the bone. The diagnosis between a case of this sort and one of

acute rheumatism will depend upon the nature and history of the disease, and on the presence or absence of constitutional symptoms of rheumatism, or rheumatic affections of remote parts. At the outset of the case the diagnosis may not be very confident; but the main point to recollect is, that any periosteal affection, if acute, is liable to run early into suppuration, and that in such cases, whatever view may be taken of the origin of the disease, whether it is to be considered rheumatic or otherwise, the local treatment is far more important than the constitutional. What Sir P. Crampton says of the acute periosteal whitlow applies with much greater force to acute periosteal affections of the larger bones: 'there are few diseases where art can do so much and nature so little.'

If the disease be allowed to go on unchecked, the whole circumference of the limb will become greatly swollen and œdematous, usually with that tense glistening aspect which tells of subjacent suppuration. The patient mostly complains of great pain, especially acute at night; he loses appetite and flesh rapidly. Pyæmia is very liable to occur, and many of these patients die of it. A few die exhausted by the violence of the action, and by the profuse suppuration. If the patient survive, and the abscess do not obtain a free and depending opening by timely incisions, it will burrow among the muscles, and ultimately numerous openings will form, exposing necrosed bone. The dead bone appears to separate much sooner than in other forms of necrosis, and the repair to be proportionally active. Thus, in an adult, almost the entire length of the shaft of the ulna was thrown off and removed three months after the injury which led to the complaint; and, even at that date, the repair appeared to be far advanced. In less acute cases, where only a portion of the surface of a bone is involved, the disease pursues the ordinary course of necrosis.

The subjects of this affection are almost always young persons,* in whom the strumous diathesis is well pronounced; but it occurs more rarely in healthy subjects about the age of

* Chassaignac says, that out of eleven cases, only one had passed the seventeenth year, and was below twenty-one; and one was only eleven months old. In the *Path. Soc. Trans.* vol. vi. p. 284, a well-marked instance is recorded at the age of eleven days. A circumstance which seems to testify to the effect of a constitutional predisposition is mentioned by Chassaignac, viz. that in some cases several acute periosteal abscesses have been present in the same subject.—*Mém. de la Soc. de Chir.* vol. iv. pp. 236-7.

puberty, or even earlier; and some cases are observed (as the one to which allusion has just been made) in adults of impaired constitution and dissipated habits.

The bone affected is, in the great majority of cases, the femur or tibia; and it is no doubt in consequence of the great size of these bones, and the severe effects which always attend upon a large abscess situated below the fascia, that the disease is so fatal. But reference has already been made to two cases in which the bones of the fore-arm were attacked; and any of the long bones may be the seat of the disease, and not unfrequently is so. The flat and irregular bones are more rarely affected; but Sir P. Crampton's case* is well known, in which an acute abscess formed beneath the periosteum of the bones of the nose and cranium on both sides. A well-marked instance of acute periosteal abscess of the sternum is described in the *Path. Soc. Trans.* vol. xv. p. 181, and another less clearly described, but probably of the same nature, in vol. iv. p. 61 of the same series.

The treatment of acute periosteal abscess is a matter of the greatest importance, as it is only by vigorous measures that so rapid and dangerous an affection can be relieved. Among these measures, the first and most important is to make timely and sufficient incisions into the swelling. If doubts exist as to the nature of the swelling, or as to the situation of the pus, they will be settled by the grooved needle; but even if no pus be found, it is better in any case of acute periosteal inflammation, where the pain is great, to make an incision down to the bone in the part to which such pain is referred. In children, it will be advisable to administer chloroform before commencing the examination when the affection is deep-seated.

Periostitis sometimes occurs in a sub-acute form, marked by rapid swelling around the bone, and by a certain amount of aching pain, but without the severe constitutional symptoms which accompany the graver disease. Incisions should not be made in these cases, unless the surgeon is sure that matter has already formed. The free application of leeches and local warmth will often obviate suppuration; and many surgeons have much confidence in iodide of potassium in full doses, as a remedy in this sub-acute form of the disease.

During the acute stage of a periosteal abscess, free exit having been obtained for the matter, the patient must be

* *Dublin Hospital Reports*, loc. cit.

treated on general principles; no special internal treatment is necessary for the affection of the bone. The indications are, to allay pain, to support the strength, and to avoid, if possible, the constitutional affection which leads to pyæmia. The last is the most important of all; patients seldom die of the 'surgical fever,' so called, which is usually present; they seldom die of the exhaustion of the discharge; but they die by pyæmia in a large percentage of the cases. How great the mortality is, it would be difficult to say, since the disease is not generally recognised in our hospital nomenclature; but out of a comparatively small number of cases which have occurred during the last few years in the surgical wards of St. George's Hospital, a very large proportion have died of pyæmia. Free and early incisions give the patient the best chance of escaping this fatal complication. No fear need be entertained of decomposition of the pus from the admission of air. In fact, pus which is confined over a bone in an acute inflammatory disease, will probably be already sufficiently putrid. The openings should at first be made in as depending a position as possible, and they should be so free as to preclude all risk of their closing again. After the opening of the abscess, free stimulation is generally, if not always, necessary. The patient will, perhaps, be unable at first to take solid nourishment, since these affections are generally attended with severe fever; but as soon as the evacuation of the matter has removed some part of the irritation, his appetite will probably return.

In abscesses which are at once deeply seated and small, it may sometimes be advisable to use a drainage-tube; but in most cases the collection of matter is too extensive to allow of this treatment being beneficially adopted, at any rate till a later period of the case, when the abscess is contracting and the incisions show a tendency to close. In the memoir of M. Chassaignac, already referred to, the author speaks highly of the advantage of injections of very dilute hydrochloric acid, which have the effect, according to him, not only of cleansing the suppurating cavity, but also of hastening the removal of superficial exfoliations by dissolving the dead bone.

If the patient has survived the acute stage of the disease, the abscess may long remain in a chronic condition, exposing the bone. In the more favourable cases, the outer shell only of the latter has perished; while in the most severe, the entire shaft, separated from the epiphyses, may come away in a mass; or

even the epiphyses themselves may share in the destruction, though that is not often the case. The treatment of these sequelæ of diffuse periostitis will be spoken of in the section on Necrosis, where also will be found discussed the subject of subperiosteal resection for acute disease.

Osteo-myelitis.—Diffuse inflammation, and suppuration, in the cancellous tissue, an affection to which French pathologists have given the name of ‘osteomyelitis,’ is more frequently recognised in post-mortem examinations than at the bedside of the patient. The more acute and more extensive cases of this affection are closely allied to pyæmia, and are usually, or at any rate very frequently, followed by that mode of death. It bears the same relation to the medullary tissue as the complaint just spoken of does to the periosteum; but the difference in character between the periosteum and the medullary tissue, the latter being so much more rich in vessels, especially in large patulous venous channels, gives to osteomyelitis a gravity even beyond that of diffuse periostitis. It is well known how often diffuse suppuration is found in the diploë of the cranium after scalp-wounds, and how the ‘puffy tumour of Pott’ is frequently only the sign of such suppuration; and further, in what a large percentage of such cases evident pyæmia is found. It is probable that in all these cases the external table of the bone has been wounded, and the diploë thus exposed; in fact, the only known cause of osteomyelitis is a wound which exposes the cancellous interior,* or an injury to the interior of the bone, perhaps unaccompanied by external wound, as in fracture. It is a frequent cause of death after amputations and other surgical operations in which bone is divided.

When a bone is examined in which osteomyelitis has run an acute course, the cancelli are found loaded with pus, and the medullary tissue usually injected and often sprinkled with ecchymoses; the periosteum also is often in the course of separation from the bone; but the bony tissue itself does not generally show any appreciable change. In the larger bones the disease usually terminates fatally at this stage; but should the patient survive, the pus may penetrate into neighbouring parts, most probably into the nearest joint, or central necrosis may result.

* Unless the infection of constitutional syphilis should be added. See *infra*, on Syphilis in Bone.

Specimens to show either of these terminations are not wanting in our pathological collections. Thus, in the Museum of St. Bartholomew's Hospital there is a beautiful specimen* of inflamed and thickened medullary membrane of the humerus, which shows, as a consequence of the inflammation, a portion of cancellous tissue exfoliated and lying loose in the medullary canal. A long fistula leads through the tube of the bone into the elbow-joint. The same museum possesses another specimen,† in which acute diffused suppuration, spreading through the tissue of many of the long bones, has caused abscess in the knees and ankles on both sides.

The symptoms of this grave affection are exceedingly obscure: it, like other extensive and acute affections of bones, is often accompanied by diffuse inflammation of the soft parts, which then masks the deeper affection. Rigors and general fever always mark the onset of acute osteo-mylitis, but the only known special symptom of the disease in the bone is the separation or recession of the periosteum from it, accompanying diffused pain in the bone, and not caused by effusion on the external surface of the latter. After amputations, a prominent fungous mass is often seen projecting from the end of the bone, and proves the existence of a certain extent of inflammation of the medullary tissue; but this need not necessarily have affected the bone so extensively as to deserve the name of osteo-mylitis; in fact, that affection is seldom recognised before death.‡

To obviate the formidable dangers, and the extensive disintegration of parts connected with osteo-mylitis, it is justifiable in any case where pain in the bone, accompanied with the ordinary symptoms of acute suppuration (rigors, fever, &c.), but without signs of external or periosteal mischief, induces a reasonable suspicion of this affection, to expose the surface of the bone by a free incision. Should the periosteum be found separated, or even separating, from the bone, the diagnosis of

* Series i. No. 207.

† Ibid. No. 195. See also No. 104, a preparation in which the whole of the inner portion of the os calcis is separating from its outer wall, as a consequence of diffused suppuration through its cancelli.

‡ If after an amputation acute osteo-mylitis be suspected, the surgeon can establish his diagnosis by putting the patient under chloroform, and ascertaining by means of the probe that the whole medullary tissue is broken up for a considerable distance, as well as the small portion which is projecting out of the wound. See Fayrer, in *Indian Annals of Med. Science*, Oct. 1865. 'The symptoms of acute osteo-mylitis are pain in the part, cedema, and swelling extending down the limb; general fever, with quick pulse, and increased temperature, and more especially the recession of the soft parts, including the periosteum, from the bone, which is then left denuded at the bottom of the wound.'—*St. George's Hospital Reports*, vol. i. p. 156.

diffused suppuration in the cancelli will be rendered highly probable. When this separation of the periosteum has proceeded to any great extent, amputation of the member, or excision of the diseased bone, is certainly indicated. It should be remembered that the disease is a rapid one, the fatal complications of internal phlebitis and pyæmia imminent; and therefore treatment, to be effectual, must be adopted early. Medicine, as might be expected, has little effect on the disease; but the fever which accompanies it should, of course, be treated on the ordinary principles. In deciding on the question of removing the diseased bone (an operation which would in ordinary cases be held to be contra-indicated if pyæmia had set in), it should not be forgotten how much the early symptoms of systemic infection resemble those of typhoid fever;* so that it may be proper in doubtful cases to give the patient the benefit of the doubt, and attempt to relieve him from the source of irritation.

In chronic osteo-myelitis the removal of the limb is frequently successful in affording the patient relief from an abiding source of irritation, which will at length otherwise prove fatal; but when this affection is limited to a portion only of the bone, the expectant treatment is indicated, and the patient may recover after the extraction of a sequestrum.†

Chronic abscess.—Limited suppuration, or abscess in the cancellous tissue, is an affection which is fortunately far more easily recognised, and far more under the control of surgery, than osteo-myelitis. It hardly needs to be said that this condition of bone was first discovered and described by Sir B. Brodie.‡ The symptoms are not always very clear, but a careful study of the case seldom fails to establish the correct diagnosis. The seat of the disease is almost always the articular extremity of the bones which form one of the great joints—knee, ankle, or elbow. The tibia is more frequently affected than any other bone, and usually at its upper end. Chronic abscess may,

* See vol. i. p. 254.

† I would refer on the subject of chronic and acute osteo-myelitis, to the well-known paper by M. J. Roux, read before the *Académie Imp. de Méd.*, and to the criticisms of M. Legouest, M. Larrey, and others on it, which are to be found in the Society's *Bulletin* for 1859-60, vol. xxv.; to a paper by Mr. Longmore, in *Med.-Chir. Trans.* vol. xlviii.; and to one by myself, in *St. George's Hospital Reports*, vol. i., quoted above.

‡ *Lectures on Pathology and Surgery*, ed. 1846, p. 395.

however, occur in any situation.* The abscess is almost always situated on the superficial side of the bone, and is probably occasioned, in most cases, by external violence, or other causes, acting on that surface; but the history is often obscure, in consequence of the chronic nature and insidious progress of the malady. The disease is said to be more frequent in England than on the continent of Europe.†

The symptoms are, a dull aching pain in the part, often worse at night than during the day, liable also to other remissions and exacerbations, and increased by exercise or pressure. In most cases the bone is especially tender at one particular spot, where the abscess has advanced nearest to the surface, and there is slight tumefaction of the soft parts over it. Sometimes, but not always, a little enlargement of the bone itself may be made out. There is perhaps nothing very characteristic in these symptoms taken separately, or on a first examination; but the persistence of the whole assemblage of them for a considerable period of time, and in spite of judicious treatment, directed to subdue an inflamed condition of the bone, will be reasonable ground for the diagnosis of chronic abscess, and more especially if the neighbouring joint be unaffected. The localised, and very circumscribed, tenderness is perhaps, when well marked, the most unmistakable symptom.

The condition of the diseased bone testifies very clearly to the nature of the morbid process, so that few museums are without some of these preparations. The following is Sir B. Brodie's description of the first preparation which he dissected:‡ 'The lower end of the tibia is enlarged, and the surface presents marks of great vascularity. The bone in the preparation is divided longitudinally, and just above the articulating surface there is a cavity as large as a small chestnut. This cavity was filled with dark-coloured pus. The inner surface of it is smooth. The bone immediately surrounding it is harder than natural.'

If the case be allowed to proceed beyond this stage, serious and frequently fatal mischief may ensue from the extension of the abscess into the neighbouring joint. Before this event

* In the Museum of St. Thomas's Hospital there are examples in the body of a rib, in the clavicle, and sternum. Series C. Nos. 84, 84², 85.

† Mr. A. Bruce, in *Med. Times and Gazette*, 1868, vol. i. p. 297.

‡ Op. cit. p. 397. The original preparation is in the Museum of St. George's Hospital, series ii. 30.

occurs, however, the patient may be much inconvenienced by repeated attacks of swelling and pain in the joint when he attempts to use the limb, the effects of slight synovial inflammation set up by the neighbouring abscess. Rest and cold applications will generally remove these symptoms, but only to recur as soon as the patient again attempts to move about. On the cure of the abscess they will immediately and permanently disappear. When the abscess has burst into the joint, the affection of the bone becomes merged in the more serious injury to the articulation.

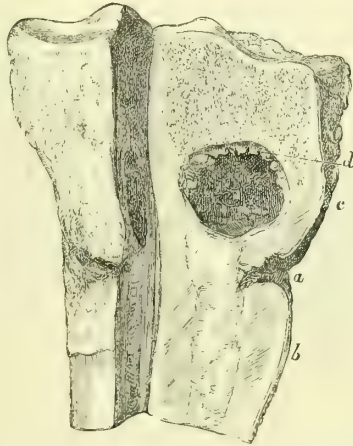
Treatment.—In all cases, as soon as the diagnosis has been so far settled as to satisfy the surgeon that operative interference is justifiable, he ought to explain the nature of the case to the patient, and endeavour to obtain his consent to the simple operation which will at once establish the diagnosis and cure the disease. There is not generally much difficulty in obtaining the consent of the patient, whom long-continued suffering and enforced inactivity have rendered greedy of any chance of relief. Chloroform should be administered, and the suspected part of the bone well exposed by a crucial incision. The bone should then be perforated to a considerable depth with a small trephine, which should not have a shoulder. If one spot on the surface of the bone appears softer than another, this should be selected for the centre of the opening. Very often pus will be seen welling up in the groove, as soon as the trephine has penetrated the compact wall of the bone. The instrument may then be withdrawn, and on the circle of bone being raised with an elevator, the pus will be evacuated. The cavity exposed is lined with a thick ‘pyogenic’ membrane, and its surface is very sensitive. The pus is only in small quantity (generally about a tea-spoonful);* but its evacuation suffices at once to relieve the patient of his wearing pain, and he is soon restored to perfect health, the cavity being filled up with a fibrous material, by which in all probability the excised piece of bone is ultimately reproduced.

Two things may interfere with the complete and immediate success of this operation—the diagnosis may have been correct, but the place selected for trephining may have been

* In an abscess of the lower end of the tibia, after an old gun-shot wound, lately under my care, there was at least half an ounce of pus. This was, I think, the largest cavity I have ever met with.

not quite the right one; or the diagnosis may have been wrong, and the symptoms have depended merely on chronic otitis. In the latter case, as may be seen by Sir B. Brodie's patient above referred to (p. 740 note), the operation will often do good, will relieve the pain of the inflammation, and perhaps prove the starting-point of a healthier action. It is well, however, remembering that this mistake has been committed by the best surgeons, to prepare the patient for it, so that he may not be too much disappointed if the surgeon shall afterwards

FIG. 188.



Unsuccessful trephining in chronic abscess of bone. *a*. The point where the trephine has been applied about half an inch from the abscess. *b*. The wall of the bone, thickened by inflammation. *c*. The cavity of the abscess. *d*. The pyogenic membrane. (From a preparation in St. George's Hospital Museum. Series ii. No. 31.)

have to confess that no pus was found. If, however, the trephine do not come down upon an abscess, it should not be forgotten that this may depend on the opening having been made on one side of the abscess, which may be lying close to the trephine-hole, but separated from it by a thin bony septum. This is illustrated by the accompanying drawing from a preparation in the Museum of St. George's Hospital. It is advisable, therefore, when the pus has been missed, before giving up the operation, to pierce the walls of the trephine-hole in several directions with a sharp-pointed instrument, in order to remove the bone freely with a chisel if a drop of pus follow any of these punctures.

Caries.—The word caries will be used in the sequel as equiva-

lent to the term 'ulceration of bone.' It is true that some pathologists of the greatest authority have limited the use of the term caries to scrofulous ulceration, and others have sought to establish a generic difference between caries and ulceration. As to the latter point, however, I must confess that a careful perusal of works in which caries and ulceration are treated of under separate heads, has failed to make me see the distinction which the writers wished to establish; and with reference to the

FIG. 190.



Strumous (or so-called 'carius') ulceration of bone. (Museum of Royal College of Surgeons. No. 625.)

FIG. 189.



Simple ulceration of bone. (From a preparation (No. 607) in the Museum of the Royal College of Surgeons.)

former, although there is as much difference between strumous ulceration and simple ulceration, when occurring in a bone, as there is between the same processes in soft parts, I cannot see that there is any more reason to attach a special name to the process as occurring in bones than in other tissues, while confusion is certainly occasioned by the use of a special term in many cases where the strumous nature of the process is only a matter of inference.

Superficial ulceration is distinguished by the following cha-

racters. The periosteum is loosened from the surface, and, if the disease is advanced, will be found much thickened, and converted into a villous mass of a pink colour, resembling a layer of granulations. This substance adheres very loosely to the surface of the bone, and, when lifted up from it, it is found to fit into depressions, which seem to have been hollowed out of the bone by the agency of the granulations. The bone at a very slight depth underneath is found, in most cases of healthy inflammation, of the ordinary consistence of cancellous tissue, which it resembles in structure even in those parts which ought to be compact. In strumous caries, on the contrary, the osseous structure will be found softened and otherwise altered, as will be described when treating of struma in bone; and it is to this combination of strumous inflammation of the body of a bone with ulceration of its surface, that the old descriptions of caries appear to be intended to apply. The ulcerated surface in healthy inflammation is superficially excavated, much softened, and easily broken down by the pressure of a probe. The interior of carious bone is softened by inflammation, its cancelli enlarged, and filled with the products of the softening and disintegration which have been going on around them. These products, as has been noticed above, are principally oil-globules, blood, and other débris of the soft tissues, and granular inorganic materials, having the same chemical composition as the salts of the bone. The soft tissues almost always take part in the morbid actions which lead to caries, and abscesses are formed which burst externally, and leave sinuses communicating more or less directly with the softened bone, and through which some part of its exposed surface can generally be felt with the probe. Abscesses, however, frequently form in the neighbourhood of inflamed bones without any actual communication with them. This is, perhaps, more peculiarly the case in childhood, and near the joints.

Symptoms.—The symptoms of caries are merely those of inflammation *plus* an abscess exposing softened bone; hence all that has been said about the frequent obscurity of the early stages of otitis will apply to caries, and with greater force, inasmuch as these ulcerative actions are more prone to occur in the course of low inflammations. Constant pain, then, in the neighbourhood of a bone, with swelling and more or less loss of the function of the part, followed by abscess which will not heal, indicate usually that the abscess proceeds from ulceration of a

bone; and this presumption is much strengthened if the pus have a putrefied, offensive odour, and a prominent mass of granulations project from the sinus; and it is converted into certainty if fragments of bone can be found in the discharge, or if the communication with the bone is sufficiently direct to allow of its being struck with a probe. When carious bone is touched by the probe, it is not usually found particularly sensitive, perhaps is not sensitive at all; it bleeds readily; its surface is irregular, and may generally be felt to be soft. When the opening is sinuous and the bone cannot therefore be struck, the diagnosis can be, of course, only inferential, and founded mainly on the persistence of the symptoms. Chemical analysis of the pus may also sometimes assist the diagnosis, since the pus from diseased bone contains more phosphate of lime than that from soft parts.* Sometimes the patient's sensations afford valuable evidence, more particularly in caries from healthy inflammation, where striking lightly over the carious part often causes the same kind of sharp pain as is felt when a carious tooth is struck.

Caries is generally accompanied by more or less of plastic or organisable effusion in the bone in the neighbourhood of the ulcerated spot, leading to condensation of the deeper parts of the bone, and to periosteal deposit of bone on the surface. This, however, is the case only in those instances where the process partakes of the healthy or sthenic character. In those low inflammations which are usually called strumous, whether connected with obvious deposit of tubercle or not, such thickening or periosteal deposit, is often absent; but the bone is softened throughout all the affected portion, the disintegration becoming less and less perceptible at a distance from the part where the loss of substance exists. The deposit around ulcerated bone frequently leads to ankylosis of the less movable joints; an occurrence which is extremely common in the tarsus.

In cases of superficial ulceration of bone, the agents for its removal are either the periosteum, when that membrane remains entire, or the granulations which spring from inflamed surrounding parts when the periosteum has been removed.† Other

* Bransby Cooper, *Lectures on Surgery*; Barwell, *On Diseases of the Joints*, p. 238, 1861.

† See Packer's *Malignant*, p. 106, for the appearances of a bone undergoing absorption by granulation for the removal of a sequestrum after compound fracture.

cases, however, of ulceration are met with, in which the disease is more deeply seated, and commences in inflammation of the membrane lining the cancelli or medullary cavity, and where, therefore, the agents for the removal of the bone are to be sought in the vessels of this membrane. Such cases as these are very rare. I am able to refer to preparations showing the reality of the affection,* but I have no knowledge of the special symptoms which it presents, or the indications, if any, which it furnishes. It is evident that, shut up as the inflamed parts are in the interior of the bone, the products of inflammation can find no exit, and the disease must soon become merged in one involving more extensive destruction, *i.e.* in diffused suppuration or internal necrosis.

A question is very frequently asked as to whether caries or ulceration in bone be a curable affection or not. To this only one answer can be given: *viz.* that no ulcerative, *i.e.* destructive, process is ever curable, in the widest sense of that term, since some defect will always remain; but that ulceration in bone, like ulceration in soft parts, may terminate in cicatrisation, or the reproduction of an inferior kind of bone which is less vascular, and less smooth and well formed than the portion which it replaces. This fortunate termination becomes less probable, the deeper the disintegration of the bone extends, and the more profound is the constitutional cachexia with which it is associated. In extensive strumous caries it is hopeless.

The *treatment* of bone affected with this form of inflammation is a matter of great importance; since upon the success or failure of such treatment, the preservation of the bone, and with it sometimes of the limb, or even the life of the patient, may depend. Ulceration in bone does not differ materially from the same process in soft parts, except in the far greater length of time which it usually occupies. In the bone, as in soft parts, the powers of nature will in most cases suffice for cure, when cure is possible, if the parts be put in a suitable position, kept at rest, and preserved clean and free from the accumulation of the discharges. But often the patient cannot wait for the completion of this natural process, and calls upon the surgeon to deliver him from the chronic malady which has become insupportable. Or, sometimes his health gives way under the protracted discharge; or, after an interval of quiescence, the

* St. Bartholomew's Hospital Museum, series i. No. 163.

caries again makes progress, and threatens to involve neighbouring bones, and to impair the functions of the whole limb, if not arrested. This is more peculiarly the case in the tarsus, and other 'irregular' bones. In the ordinary treatment, then, of caries, no other local measures are required than to provide a free exit for the discharges, and to keep the exposed surface of bone clean. The appropriate constitutional treatment will complete all that art can do to promote recovery, and more active surgical interference is not only useless but hurtful, as it risks doing harm without a reasonable prospect of doing much good. Incisions, however, should not be spared to the utmost extent necessary to keep the discharge free, or perhaps even somewhat beyond this limit. In fact, in all the acuter cases of osteitis, much benefit appears to follow the mere division of the tense structures over the bone. When the surface can be felt exposed and carious, it is still more necessary to have a free discharge; since otherwise, the pus, being confined, may burrow beneath the periosteum, and extend the mischief to the neighbouring parts of the bone.*

Often after this free exposure of the carious bone, the disease will gradually subside; but when this is not the case, the question occurs, whether it will be proper to attempt to remove the carious surface and expose a more healthy one, either by rasping or gouging the bone, or by the application of the actual cautery; or to modify the diseased action by injections, or by applications to the carious part. The injections which are in use are composed either of iodine or dilute mineral acid. The latter is intended to unite with the base of the phosphatic salts of the bone, and thus to remove its surface by disintegrating successive portions of it. It has been tried, and is strongly recommended by M. Chassaignac;† and no objection appears to exist to its employment in suitable cases; but I cannot say that I have found much benefit from its use. The injection of tincture of iodine in the treatment of abscess depending on disease of inaccessible portions of bone (as in psoas and lumbar abscess), has been warmly extolled by M. Boinet.‡ But

* Some authors teach that pus exercises a solvent power upon the bony tissue itself. This doctrine appears unsupported by direct evidence; and it seems improbable that the bone can be so dissolved while it retains its vitality.

† *Mém. de la Société de Chirurgie*, loc. cit.

‡ *Ibid.* vol. ii. p. 454.

M. Robert, who has tested the practice by numerous trials, pronounces (what indeed theoretical reasoning would have led us to expect) that M. Boinet 'has singularly over-estimated the good effects of iodine,'* and from the few trials that I have had the opportunity of making, I believe that M. Robert's estimate of this treatment is very near the truth. The iodine may be used diluted at first, with one or two parts of water; and afterwards the pure tincture (Lond. Phar.) may be used. It is better at first to withdraw as much of the injection as will run out, and cover the opening with a poultice. Numerous injections will be necessary.

In cases of superficial caries of bones which can be exposed without too much injury to the soft parts (of which the tibia and calcaneum are the most familiar examples), it may sometimes be advisable to rasp or gouge away the carious surface of the bone, and endeavour to arrest the further progress of the disease by the application of the actual cautery or strong nitric acid to the surface so exposed; or, if the disease be very superficial, the latter measures may be sufficient, without any preliminary removal of bone.

Mr. Pollock has employed the application to the carious surface of sulphuric acid, at first diluted with an equal bulk of water, and then more and more nearly pure, pencilled on the surface when exposed by turning away the soft parts. The first application dissolves a portion of the exposed bone, and chars and kills the rest of the surface; when this comes away, if more dead or diseased bone is exposed, it can be similarly treated until a healthy granulating surface is reached. In this way also superficial exfoliations of necrosed bone can be removed. I have witnessed the success of this plan in the hands of my colleague, and can speak also favourably of it from my personal experience.

Another plan, which is applicable also to the treatment of caries in more deeply-seated bones, has been proposed by Dr. Fitzpatrick.† He converts the sinuses leading down on to a diseased bone, into a large funnel-shaped opening, by the repeated action of the Vienna paste (potassa cum calce), and having thus brought the diseased bone within reach, he pierces its tissue with a strong knife, trocar, or small trephine, and

* Robert, *Conférences de Clinique chirurgicale*, p. 208. Paris, 1860.

† See *New Syd. Soc. Biennial Retrospect*, 1867-8, p. 259.

then freely cauterises the full extent of the perforation. The cauterisation is to be repeated till the whole extent of the disease seems to be removed, and the use of the limb is restored. Necrosis can, according to Dr. Fitzpatrick, be treated in the same way : 'the caustic being very freely used, destroying all foul undermined integument, and leaving large clean circular openings, more than an inch in diameter, and extending deeply down into the sequestrum, into contact with which the caustic in stick and powder is to be freely brought.' He recommends it also in simple inflammation (a recommendation in which I cannot say that I concur) ; but not in diffused suppuration. My personal experience of this treatment has been limited, and in one case which seemed peculiarly well suited for the treatment, and where the disease, which was seated in the ankle, was in a perfectly chronic state, the patient died of pyæmia.

These operations should, however, only be performed in cases of evident necessity. We have only too frequent instances of the dangers of all operations on bone, especially of such as involve the exposure of large surfaces of the cancellous tissue, as is generally the case in these gouging or rasping proceedings, which are extremely apt to be followed by diffused inflammation of the interior of the bone (osteomyelitis) and by pyæmia. Still, if the disease be accompanied with much pain and loss of motion, and the wound show no tendency to heal, the patient is often compelled to have something done for his cure, as otherwise he would lose his means of livelihood ; or the surgeon may think it right to interfere in order to arrest the progress of the disease into neighbouring organs. The decision of such questions as these must, of course, be left to individual judgment.

The application of the actual or potential cautery appears to be less dangerous than cutting operations, and is often successful in superficial caries. It seems less in use than might be expected, considering the many cases of caries limited to one, and that a superficial, bone of the tarsus and metatarsus, which are seen, especially in children. Here, however, and in all situations where a bone can be removed without prejudice to the function of the part, excision is so much more satisfactory when any large part of the bone is involved, that it is, perhaps, not wonderful that the less radical measures are not much in use.

M. Sédillot has proposed a more extensive use of the operation of scooping or gouging carious bone, as a substitute for excision or amputation.* His plan contemplates the removal, by the gouge, of the whole bone except a shell of the outer healthy parts, which is left to effect the restoration of the bone. With all due respect for the authority of M. Sédillot, it seems impossible to allow that such a proposal is either useful or safe. There are few cases of extensive and deep-seated caries in which the limits of the disease can be ascertained, and a partial operation is often worse than none at all. Besides, extensive exposure of the interior of a bone is a most hazardous proceeding, and only too often terminates in pyæmia. M. Sédillot, however, is said to have performed his operation thirteen times without any instance of such complication. The further consideration of this question will occupy a portion of the essay on EXCISIONS.

Ulceration in bone is not always of this chronic nature. Mr. Stanley has described† some cases of ‘phagedænic ulceration’ of bone which seem to have been connected with the occurrence of rodent or cancrioid ulcer‡ in the soft parts; and in diseases more distinctly partaking of the nature of cancer the bones may be destroyed with great rapidity; but here the affection in the bones is only a part of the general disease, and its treatment must depend on the view which may be taken of the latter. Cases of rapidly spreading ulceration do, however, occur, in which the bone alone is affected.

Two remarkable instances have been put on record by Mr. Cæsar Hawkins;§ in one of which the disease was only part of a general strumous affection, but peculiar on account of its extreme rapidity and great extent. The other was a very remarkable instance of removal, by disease, of great part of the skull-cap, and protrusion of the brain through the opening so left; but without the formation of pus. An abscess was found in the brain, but this was connected with violence done to the protruded portion of that organ, and not with the disease in the bones. No distinct proof of the presence of any constitutional cachexia was obtained, nor was the exciting cause of the complaint apparent. Its inflammatory nature was testified by distinct marks both of inflammatory thickening and of inflammatory erosion on the bone in the neighbourhood. Therefore the old definition of ulceration as ‘absorption from inflammation’ would strictly apply to this extraordinary case; and we have already seen (see pp. 731, 2) that

* *Lancet*, Dec. 10, 1859. Sédillot, *Sur l'Évidement des Os*.

† *On Diseases of the Bones*, p. 65.

‡ See vol. i. p. 196.

§ *Med.-Chir. Trans.* vol. xxxix. p. 285.

the formation of pus, though an ordinary, is not an absolutely necessary, feature in ulceration of bone ; but it is rarely indeed that so large a portion of bone is removed without the formation of abscess, especially when compact tissue is involved ; for the instances of removal of inflamed bone without suppuration, hitherto noted, have occurred almost exclusively in thick cancellous bones, such as the vertebræ and tarsus.

Necrosis, or the death of some considerable portion of a bone, occurs as the consequence of any cause which sufficiently impedes the circulation in the neighbourhood. This is precisely analogous to what takes place in the gangrene of soft parts ; and as in gangrene the non-vascular parts are most easily affected, and then those which, though vascular, are furthest from the centre of the circulation, and in which the vessels are fewest and smallest, so the frequent occurrence of necrosis of bone is, no doubt, due to the comparatively small quantity of blood which circulates in that tissue, as well as to the inextensible nature of the osseous substance itself, in consequence of which any extravasation or product of inflammation causes pressure directly upon the blood-vessels, or narrowing of the channels for the conveyance of the nutritive plasma.

It is denied by some authors of reputation on this subject that necrosis is ever a consequence of inflammation of bone,* and they refer the disease always to periostitis or osteo-myelitis as its cause. But this appears an error in two senses. In the first place, there is no essential difference between periostitis, or osteo-myelitis, and inflammation of bone. The diseases so called are only inflammations in which the part of bone alone affected, or, as is much more common, the part *most* affected, is the external table or the medullary tissue. In the second place, the disease properly called *ostitis* very frequently induces necrosis, not indeed usually of the inflamed part, but of the parts in its neighbourhood. The inflamed part itself does not usually perish, because the final cause of necrosis is the stoppage of the circulation by the obstruction or obliteration of the vascular channels, while the first effect of inflammation is the enlargement of those channels. When the *ostitis* has reached the stage of exudation, the dilated vascular channels become again narrowed ; but the process takes place slowly, and organisation which involves the formation of new vessels, takes place in the exuded material as it is produced. Still, although the event is

* Gerdy, *Maladies des Organes du Mouvement*, p. 217. 1855.

not a common one, traces of inflammation are seen on sequestra sufficiently often to show that the inflamed part does sometimes die. The same causes, in fact, which produce gangrene in soft parts will occasion the death of a bone ; and among them inflammation holds a high place, less on account of its direct effect, *i.e.* its tendency to produce the death of the part inflamed, than of its indirect consequences, whereby the circulation around the inflamed part is obstructed, and so necrosis of the neighbouring parts is induced. Hence in the course of an extensive caries the circulation of some considerable portion of the bone is apt to be destroyed, and then a necrosed or loose piece is found in the middle of the ulcerated part. Such combination of necrosis with caries was called by the old writers dry caries or hard caries.

Another very frequent, if it be not the most common, cause of superficial necrosis is the denudation or separation of the periosteum, which occurs as a consequence either of direct injury or of effusion between it and the bone. It is true that large separations, and even extensive destruction of the periosteum may occur without the death of any portion of the bone, and this is indeed common in the bones of the head and face ; but the peculiar circulation in the former, and the great vascularity of all parts in the latter region, sufficiently explain this fact. In other parts, it is the more general rule that when the periosteum is destroyed or separated over any considerable portion of a bone, the superficial layers of the latter will perish. This is one reason, among many, why it is important to adjust the soft parts over a bone denuded by violence, in order that they may rapidly adhere to it, and that so fresh vessels may connect the periosteum to the bone before the latter has undergone an irremediable change.

Violence, acting directly upon the bone, is another very frequent cause of necrosis, as is frequently seen in compound fracture, where both the periosteum and the medullary tissue are much damaged, and the bone dies without any proof of previous inflammation having existed.

The action of cold is often exhibited on the bones as on the soft parts, and the subject will be found treated of under the head of Frost-Bite (vol. i. p. 169). In deep burns the bones are also occasionally charred, and they are frequently involved in gangrene of the superficial tissues, from whatever cause it arises. Certain caustic applications are well known as frequent

causes of necrosis, of which the superficial exfoliation produced on the surface of the jaw for the cure of epulis is a familiar example. To this category belongs also the necrosis of the jaw which is produced by exposure to the fumes of phosphorus.* The various constitutional cachexiæ, especially syphilis and struma, are frequent causes of necrosis; but here the affection of the bones is only a variety of the inflammatory process.

The abuse, and even occasionally the moderate use, of mercury is another cause of necrosis. It is quite true that many of the preparations and cases entitled 'necrosis from the abuse of mercury' may be explained as having been cases of syphilitic necrosis, in which mercury had merely failed to arrest the disease, and had had nothing to do with causing it; but there are too many instances on record of the occurrence of necrosis of the jaw, during the administration of mercury for some disease which has no influence upon the bones, to admit of a doubt that the affection was directly induced by the so-called remedy. Thus, in the Museum of Guy's Hospital (No. 1,091) is a sequestrum consisting of two-thirds of the alveolar process of the lower jaw, which is said to be 'necrosis induced by the use of mercury for ovarian dropsy.' Unfortunately it appears that what is a moderate use of mercury in one person, is equivalent in rare cases of idiosyncrasy to an excessive abuse, so that no practical rule can be laid down; but it is at any rate proper to remember this occasional effect of mercury, particularly when prescribing it for cachectic persons. In the Museum of St. Bartholomew's Hospital is a preparation, in which necrosis of the jaw is attributed to the administration of a few grains of mercury during a fever; but in some fevers necrosis has been frequently observed as a consequence of mere lowering, as it would seem of the vital powers, without any mercurial cachexia.†

It would be idle to attempt an enumeration of all the causes which may lead to the death of bone. The above are the most common, and will be found sufficient for practice. The symptoms and treatment are identical in most of these forms. Some will require special notice hereafter.

* This affection will be found treated of in the essay on SURGICAL DISEASES OF THE TEETH AND GUMS.

† See, in the Museum of St. George's Hospital, series ii. Nos. 91, 95, preparations in which both the jaw and the clavicle became necrosed in the same patient during the course of a fever.

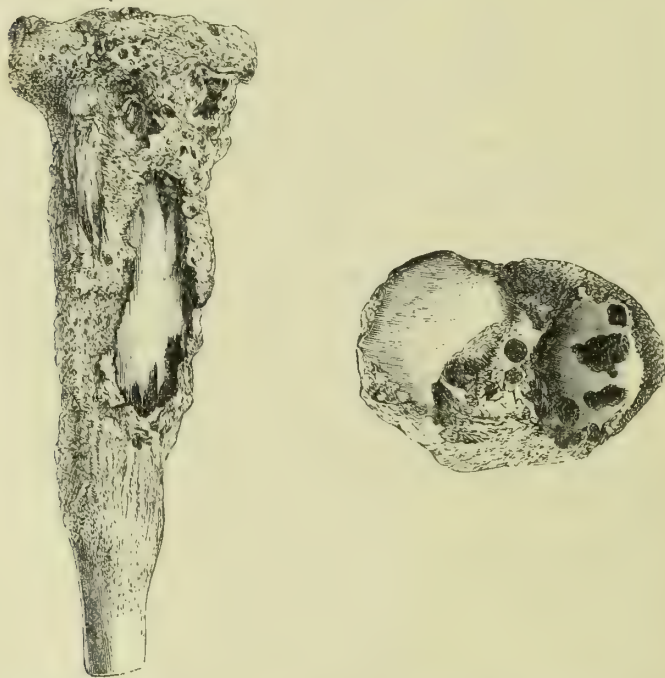
When a portion of bone is to die,* the first phenomenon is the cessation of circulation in it. This leaves it hard, white, and sonorous when struck. It does not bleed when exposed or cut into, and is insensible. Occasionally, when the dead bone is exposed to the air, and acted on by the presence of putrid pus, its colour becomes nearly or quite black; large surfaces of hard, black, necrosed bone are sometimes left exposed by the sloughing of the skin over the tibia. The dead bone at first retains its connection to the bone around, as well as to the periosteum, or whatever part of the nutrient membrane may belong to it; but the presence of a dead part is never long tolerated by the living tissues, and accordingly the processes which are to eliminate it soon become perceptible on both these structures. The periosteum, or medullary membrane, as the case may be, separates from the dead bone and becomes inflamed, a quantity of ossific deposit (more or less, according to various circumstances) is poured out between it and the dead bone, and this deposit soon becomes converted into new bone, forming a sheath over the dead portion, by which the latter is enclosed, or *invaginated*, as the technical term is. The dead part is now called a *sequestrum*, a name only properly applied to it when loose and invaginated, though often incorrectly used of any piece of dead bone. While this sheath is being formed from the membrane coating the dead bone, changes are going on in the living bone to which it was attached. When the latter has been previously diseased (*i.e.* when the necrosis has been of inflammatory origin), the inflammatory deposit which surrounds the sequestrum softens, pus is formed, and a groove of ulceration is produced at the expense of the circle of inflamed bone which forms the margin of the sequestrum. If the surrounding bone have been previously healthy, the sequestrum acts as an irritant upon it, setting up, first inflammation and thickening to a variable distance, and then ulceration. Thus a groove is traced around the sequestrum; and the formation of this groove is accompanied by suppuration, as has been described above (see p. 735). The pus formed in the neighbourhood of the dead parts makes its way to the nearest surface, and in so doing interrupts the formation of the periosteal sheath, leaving sinuses, or *cloacæ*, passing through this sheath from the sequestrum to

* This description refers to the process as it occurs in bone previously healthy.

the surface of the body, or sometimes into a neighbouring joint or serous cavity. The presence of such sinuses, leading through the shell of bone to hard, smooth, sonorous bone at the bottom of the cavity, is the distinguishing mark of necrosis. Most of these points are illustrated by the accompanying figure.

The formation of the groove between the dead and living bone is a very slow process in the bones of the limbs, requiring generally many months for its completion. It is impossible to

FIG. 191.



From a preparation (No. 3,174) of necrosis of the tibia, in the Museum of the Royal College of Surgeons. To show the various points connected with necrosis of a portion of the shaft of a long bone—the sequestrum—its invaginating sheath, formed in a great measure by periosteal deposit, and terminating on the healthy surface of the bone, at some distance from the seat of disease, the openings, or cloacæ, through which the sequestrum is exposed, and (in this instance) the implication of the neighbouring joint from the extension of these cloacæ into it.

lay down any rule as to the time at which a sequestrum may be expected to be found separated from the rest of the bone. In animals, as has been proved by experiments,* the process may be completed in a few days. In children it seems to go on sometimes with great rapidity, especially in the bones of the

* Troja, *De novorum Ossium Regeneratione*, exp. i.

face. On the other hand, instances are not wanting in which half a lifetime may have elapsed, and the process still remain unfinished.

One of these has furnished a preparation in the Museum of St. Bartholomew's Hospital.* It is the section of the shaft of a femur, exhibiting in its interior a small fistulous cavity, with necrosis of a small portion of the inner layers of its wall. A groove extends to some depth between the dead and the contiguous living bone. The limb was removed by amputation. The femur had been fractured thirty-five years previous to the amputation; the fracture was followed by abscess in the soft parts, and the formation of a fistulous passage leading to the interior of the bone, which passage remained open during the whole period from the fracture to the removal of the limb.

It may, however, be stated generally, that the more superficial the dead portion is, the more freely it is exposed, and the more violent the action of the cause has been, the more rapidly will it separate (see p. 743).

When the groove is completed, the dead bone is loose in the cavity so formed for it, and quite free from any vital connection to the body. The sequestrum, therefore, is now eliminated, and this may be regarded as the natural process of cure, since it prevents the extension of the necrosis further into the bone; but as the sequestrum is still lodged in its cavity in the interior of the bone, it thus becomes an abiding source of life-long irritation, which must by all means be removed as speedily as possible.

The above is intended for a sketch of the process of necrosis in one of its most frequent seats, viz. the outer (subperiosteal) layers of the compact sheath of a long bone; but it may occur in any situation—in the medullary canal, or central layers of the compact tissue, in flat or irregular bones, or the spongy ends of long bones; or again, the extent of the necrosis, or the situation of the part, may modify considerably the process of separation, *i.e.* the surgical aspect of the case. For example, even when necrosis is subperiosteal, and the process of separation normal, it may be in a part from which extraction is impossible, as on the inner surface of the skull, spine, pelvis, thorax, &c. The subperiosteal sheath is often wanting in the bones of the limbs when the soft parts have been extensively destroyed over the affected bone; and it is never formed in the skull, where necrosis is so common, nor in the cancellous bones, where, though less common, the disease is by no means rare.

* Series i. No. 176.

In such cases, when the dead bone is loosened from the living, it comes away of itself, or can be at once removed. Such a piece of dead bone, not confined by an invaginating sheath of new bone, is called an *exfoliation*. Again, it sometimes happens that the necrosed portion involves the whole thickness of the shaft of a long bone, and sometimes the whole length of its diaphysis; some instances even are exhibited in the museums where the epiphysis also has perished along with the entire shaft, though this is very rare.* Necrosis also sometimes attacks the epiphysis only, and even, as it seems, the deposit of bone which in early life forms the centre of ossification for the epiphysis.†

Each of these conditions is accompanied by noticeable peculiarities. When the whole thickness of the shaft is involved, especially in a bone, like the humerus, enjoying free and rapid motion, fracture is likely to follow on the completion of the groove, although this result may be obviated by the strength of the case of new bone. When the whole diaphysis is involved, the case assumes a graver aspect, since the extent of inflammation which is necessary for the formation of the new shaft, and the great suppuration thereby produced, suspends, or perhaps permanently abolishes, the functions of the limb. The muscles become matted together, the skin œdematous and penetrated by numerous sinuses, the parts below incapable of extended motion or energetic action; cases even are on record where the inflammation, having reached the great vessels, has produced coagulation of the blood in both artery and vein, and consequent dry gangrene of the limb.‡ In other cases either the ulceration around a sequestrum, or other disease of the bone, involves a large vessel, or the point of an exfoliating portion of bone is driven into the artery in some movement of the limb; §

* Guy's Hospital Museum, No. 1160³⁰, necrosis of the condyles and shaft of the femur, and upper end of the tibia. See also No. 1160²¹⁸, referred to farther on.

† See a case in my work *On the Surgical Treatment of Children's Diseases*, 2nd edit. p. 389. (Edward J. Eade.)

‡ Museum of St. Bartholomew's Hospital, series i. No. 134.

§ Mr. Poland, in his essay 'On Rupture of the Popliteal Artery,' quotes one case of spontaneous hæmorrhage from that vessel in necrosis of the femur (a patient of Dr. Porter, *Dublin Journ.* vol. v.), and two others where the artery was wounded by a sequestrum during active movements of the limb (Dr. Byron's case, *Med.-Chir. Rev.* vol. xxiv. p. 259; Dr. Jacob's *Diss. Med.-Chir. de Aneurism.* Edin., 1814). I have seen fatal hæmorrhage from the lingual

and thus either a direct wound of the artery is produced (when the sinus of the diseased bone communicates with the laceration in the artery), or if no opening exists externally, a consecutive aneurism may possibly be established. In any case of such injury to the main vessels, when the diagnosis can be properly established, amputation would be indicated in the lower limb. In the upper limb the main arteries are separated from the bone by a mass of soft parts; and smaller vessels would hardly complicate the case, as they might be included in the incisions required to expose the diseased bone. In other situations attempts must be made to tie the ulcerated vessel; and if they fail, as they generally will, from the rotten condition of the parts, the trunk leading to it must be secured by ligature or acupressure.

In cases of necrosis involving the whole thickness of a bone (*total* necrosis), when the seat of the disease is a large bone, such as the femur, life is in considerable danger; and as the patients are usually persons in whom some constitutional cachexia is present, and probably in an advanced stage, they frequently succumb.* Still the dangers of amputation in these cases are so great, and the advantages of saving the limb so decided, that they are usually left to the reparative powers of nature. In small bones, such as the phalanges, amputation is indicated. In the upper limb large portions of the whole thickness of the shaft may be removed with entire success, and preservation of the motions of the extremity. In the essay on *Excision*, the indications for excision of the whole or parts of bones on account of necrosis, involving their whole thickness, will be further considered.

Central necrosis is usually an obscure complaint, and is hardly distinguishable by its symptoms from chronic abscess of the bone. In fact, as their symptoms are the same, so the same treatment is applicable to each of them. Deep-seated pain, throbbing, loss of rest, general debility, perhaps rigors

artery in disease of the jaw, and from the aorta in caries of the spine. Mr. Stanley (op. cit. p. 111) relates a case in which the capsule of the knee joint was penetrated by the pointed end of the necrosed shaft of the femur.

* An interesting case of total necrosis of the shaft and upper part of the femur in a young subject, aged thirteen, in whom amputation was successfully performed a year and a half after the commencement of the disease, is recorded by Mr. Kerr of Aberdeen in the *Ed. Med. and Surg. Journ.* 1834, vol. xlii. p. 98. It is worth perusing, as showing the activity of repair at that early age.

and some amount of fever, with slight puffiness over the seat of the disease, and a little pain on pressure; these symptoms persisting for a considerable period without relief, notwithstanding that the appropriate constitutional and local remedies have been employed, indicate the necessity of making an exploratory incision at the seat of the inflammation, and, if the surface be found healthy, of removing it with the trephine in order to search for an abscess or sequestrum in the centre.

Deep-seated necrosis often leads to suppuration, making its way to a free surface. This is very common in the long bones, and is a frequent cause of abscess and destructive inflammation of the joints. Necrosis may also attack a portion of the articular surface of one of the great joints of the body, although this is rare except as a complication of extensive strumous affection of the joint-surface. Limited necrosis of articular ends is, however, occasionally met with, and, like the previous affection, will set up abscess in the joint. The diagnosis of these causes of articular abscess must be sought in the essay on DISEASES OF THE JOINTS, and the indications for operative treatment in that on EXCISION.

In the flat bones, where they are formed of compact tissue, necrosis is an exceedingly common disease; but here, as has been before observed, the dead bone will usually exfoliate without invagination. The same may be said of the necrosed portions of irregular bones, which consist almost entirely of cancellous tissue (such as those of the tarsus), in which necrosis is by no means rare. Whole bones, or large portions of entire bones, of the tarsus, and sometimes, but less often, of the carpus, are found quite separate from all their attachments, and merely retained as foreign bodies among the soft parts. In such cases there is sometimes a little difficulty in making the diagnosis; since the dead bone has not the hard ringing sensation usual in necrosis of compact tissue, and the large size of the necrosed piece sometimes prevents it from moving under the probe. The case, therefore, simulates one of caries.

This difficulty was experienced in the case of a little child under the writer's care, in whom a sinus existed leading down upon the os calcis. The probe passed down to soft bone, not in the least movable, and crumbly to the touch. On the soft parts, however, being turned back, it was found that the posterior part of the calcaneum, involving at least half the bone, was dead and quite separated from the anterior part. This having been removed, the child made a rapid recovery. I have seen similar cases in childhood repeatedly, and more especially about the tarsus.

However, though the cancellous tissue is sometimes affected with necrosis, it should be remembered that this is exceptional, and that necrosis is an affection more peculiarly of the compact tissue, and especially of the densest bones. Thus the petrous bone is frequently necrosed, and has been known to exfoliate almost entire.*

Treatment.—Hitherto we have been considering the usual method of separation; and as this is a long and tedious process, seldom completed under many months in the case of a large sequestrum, and often dating by years, it is not surprising that efforts should have been constantly made to anticipate the period of cure by cutting away the diseased bone. These, however, have hitherto resulted in disappointment. The process must be left to find its natural completion in the spontaneous separation of the dead bone from the living; and any attempt to effect this by operation, *i.e.* to detach the necrosed portion, and to cut it away from the living parts, only extends the area of the disease, and endangers the preservation of the limb. Special considerations, applicable to some regions of the body, such as the skull, may indeed induce a surgeon to operate on necrosed bone before it is loose, for the relief of matter pent up below it: such operations, however, are not undertaken with a view of curing the diseased bone, but of restoring the function of organs secondarily affected. Such has been the result of surgical experience up to the present time. I have, however, pointed out above (p. 757), that a sequestrum of limited extent may be dissolved out by the action of sulphuric acid, or probably of potassa fusa, and thus the slow process of vital action necessary for its separation may be anticipated. In order to obtain success, however, in these proceedings, it is essential to know exactly the limits of the disease.

But when the sequestrum has separated and lies loose and invaginated in new bone, surgical interference is most necessary. There is perhaps no part of surgery in which the improvements effected in comparatively modern times have done so much to preserve life and limb, and to obviate pain, as in the treatment of necrosis. The invaginated portion of bone can never get out by any natural process: the very completeness

* *Path. Soc. Trans.* vol. vii. p. 335. A similar case occurred at St. George's Hospital, under Mr. Prescott Hewett's care; *Museum, St. George's Hospital*, series ii. 99.

and efficacy of the efforts which nature makes to preserve the continuity of the bone, and to restore its strength, effectually imprison the dead portion. Small pieces or granules of dead bone constantly exfoliate from carious surfaces; but when the sequestrum is of any considerable size, the cloacæ are never so large as to admit of the escape of the sequestrum through them, although sometimes they are very nearly large enough. Thus, in the Museum of St. Bartholomew's Hospital, there is a curious specimen,* in which a small piece of loose bone, just too large to get out of any of the numerous cloacæ which have formed around it, is found rattling about in its cavity as if in a dice-box.

The requisite operation consists in cutting down on the dead bone, and exposing it sufficiently to remove it. If the necrosis be superficial, nothing is required beyond turning back the soft parts, which have no connection with the dead bone, elevating the latter, and pulling it out with a pair of forceps. But, for the removal of an invaginated sequestrum, it is necessary to open the sheath by enlarging one of the cloacæ with the trephine, or cutting forceps, until it is large enough to admit of the extraction of the piece. Sometimes, when the sequestrum involves a large portion of the shaft of the bone, it may be found impossible to get the piece away until a pair of cutting forceps or a trephine has been introduced through the enlarged aperture, and the dead bone divided. In the necrosis which so often attacks stumps after amputation, a ring-like piece may separate from the end of the divided bone. Its extraction is then a matter of considerable difficulty; but still, as there is a free opening on to the extremity of the dead bone, it may be accomplished with some little trouble. If a similar sequestrum should form on one of the long bones, involving a ferule-like portion of its surface, its removal would be still more troublesome, requiring free incisions on both sides of the limb: but I am not aware that such cases have been noticed in practice. A preparation in the Museum of St. George's Hospital (series ii. 75) shows a strip of necrosed bone winding spirally, for a considerable distance, round the shaft of the humerus.

It has sometimes been made a question whether the sequestra of necrosed bone can be removed by a gradual process of disorganisation and molecular decay. If this question be proposed

* Sub-series A, No. 94.

as an essay in scientific pathology, there is no doubt of its great interest; but viewed as a practical consideration in surgery, hardly any value attaches to it. Experiments on animals certainly appear to show the possibility of the removal of small pieces of excised bone reimplanted in the excision-wound;* and it is possible that, in the human subject, sequestra of bone may be to some extent eaten away by a process of absorption like that which sometimes removes the ivory pegs driven into bones for the cure of ununited fracture (see vol. ii. p. 92);† but even allowing all upon this head which any one could reasonably deduce from such facts as these, we should still be justified in saying that the process is so slow, so uncertain, and so partial, that no account ought to be taken of it in surgery.‡

It is therefore necessary, in every case in which a sequestrum forms, that a surgical operation should be undertaken for its removal. The word *sequestrum* is here used in its strict sense, to express a portion of dead bone contained in a case of new bone. An *exfoliating* portion of bone may separate and be thrown off by the natural processes, though it is usually necessary to facilitate its removal when loose by incisions.

A question is sometimes raised, whether it is prudent to operate as soon as the operation is possible, *i.e.* as soon as the bone is loose, or whether a certain time should not rather be given, in order that the newly formed bone may become conso-

* Heine, in *Gräfe und Walther's Journal*, Bd. xxiv. p. 527, quoted by Wagner, op. infra cit. p. 146.

† A case showing this absorption very clearly has been put on record by Prof. Cleland, in the *Brit. Med. Journ.* for Feb. 22, 1868.

‡ It may reasonably be doubted, also, whether the absorption said to have occurred in some of the experiments above referred to did really take place, or whether the whole thing was not a mistake on the part of the experimenters. Gulliver's experiments (*Med.-Chir. Trans.* vol. xxi.) show that portions of loose bone, thrust into the tissues of living animals, may remain an indefinite time without experiencing any absorption, as proved by careful weighing at the beginning and end of the experiment. Again, cases such as that quoted on p. 765, prove that a portion of bone, of no extraordinary size, may remain necrosed during a great part of a lifetime, and suffer no perceptible diminution in size. This is the case even when its mechanical connection with the rest of the body is not entirely destroyed. But surely when loose and separated from the living tissues it must be still less under the influence of the vital actions. In a paper by Mr. Savory, in the *Med.-Chir. Trans.* vol. xlvii., several experiments are described, showing that the absorption of dead bone driven into the living bones of animals, is proportional to the pressure to which it is subjected, a condition which hardly exists in the cases of necrosis that occur in practice.

lidated, and the limb sufficiently strong to perform its functions. The question, however, is rather fanciful than practical. No harm appears ever to result from taking away a loose piece of bone, but much mischief often follows on its being allowed to remain. If, in rare cases, the bone is left too weak to bear the weight of the body or the motions of the limb, it is probable that this is a consequence, either of such extensive destruction of periosteum as finally to preclude reproduction, or of some constitutional fault, or other predisposing cause. The inflammation excited by the presence of the sequestrum in the neighbouring bone has probably not passed the stage of softening; while, from the same low rate of the morbid processes, the bony deposit furnished by the periosteum has been small in quantity and low in organisation. In such a case as this it would appear that the best chance for restoring to the bone its proper density would be afforded by the operation which would relieve it of the cause of the inflammation whereby its cohesive power is being destroyed. It would, therefore, be far more rational to remove the dead bone, and put the limb at rest, than to leave the source of irritation, and expect a cessation of the effect from perpetuation of the cause.

It is not always easy to determine the question, whether the bone is loose or not, since the growth of the periosteal sheath, or even the shape of the loose portion, and the arrangement of the parts around it, may prevent it from moving under the probe. Of this fact an instance has been given above (p. 768), and the reader may consult a clinical lecture by Mr. H. Smith, *Medical Times and Gazette*, March 22, 1862. In cases, therefore, where the disease has lasted so long that the separation may be reasonably expected to be complete, it is right to endeavour to remove the bone, even although the probe has not given decisive evidence that the operation can be carried out.

It is necessary here to say something respecting the agents, and the manner, of regeneration of bone after loss of substance from necrosis. In doing this, however, it would be impossible in an essay of this sort, to go into the question with any approach to completeness; but it is hoped that enough will be found in the following paragraphs to illustrate the points necessary for practice. The student who wishes to learn more about the matter is referred to the works of Troja, Weidmann, Flourens, Syme, and Wagner.

The most important agent in reproducing bone lost by

necrosis is, without doubt, the periosteum; and this membrane is sufficient of itself to replace all the ordinary exfoliations and partial necroses which follow injuries, &c. The osteogenic properties of the periosteum, when in contact with the bone, have long been known, in fact must have been apparent when the function of the membrane was first studied; and that periosteum, when separated from the surface of the bone, will still generate new bone, is no very novel discovery, since John Bell seems to have been perfectly acquainted with the fact, and describes the formation of a bony cyst by secretion from the detached periosteum, around a collection of blood which had dissected off that membrane from the bone;* and the experiments of Syme and Stanley are well known. Lately the osteogenic powers of periosteum have been placed in a very striking light by the experiments of M. Ollier of Lyons.† He has shown that, in rabbits, portions of periosteum may be entirely detached from the bone, and pushed into the cellular tissue of the limb, or even grafted into remote parts of the body, or into the body of another rabbit, and that bone would be generated from the fragment of periosteum in this novel position. He has even succeeded in producing bone by such grafting of portions of periosteum kept for more than an hour out of the body.

It is far from certain, nay, it is most improbable, that any such results could be produced in man, since the conditions of all reproductions, and especially of reproduction of bone, are known to differ so much in man and animals; but, even if the vitality and osteogenic power of the periosteum be less in the human subject than in the lower animals, still it seems reasonable to infer, from observed phenomena, that that power is of the same nature; so that these striking experiments may serve to fix more firmly on the attention of surgeons the importance of preserving the periosteum in cases where the reproduction of lost bones is in question. In all cases, then, where loss of substance in bone has taken place, or where the bone seems

* *The Principles of Surgery*, by John Bell; a new edition, by Charles Bell, 1826, vol. iv. p. 406. The pathology of the case, as related by the author, is sufficiently obscure; but the case may be used to show that Bell knew that bone could be formed from the detached periosteum.

† *British Medical Journal*, 1860, pp. 398, 438; *Traité de la Régénération des Os*, Paris, 1867. I may mention that some of M. Ollier's experiments have been repeated and verified by numerous experimenters, amongst others by myself.

deprived of life, it is of the greatest importance that the periosteum should be preserved, a point which will be noticed again in the essay on EXCISION, in speaking of sub-periosteal resection.

It has frequently been made a question, on what this power of reproduction depends, whether on the action of the fibrous membrane itself, or on the detachment, together with its lower strata, of small particles from the surface of the bone, which serve as nuclei, around which new bone grows. It is not easy to prove that such nuclei are not detached in every case; but there is no evidence that such is the fact. Bone has often been known to be produced from portions of periosteum which had been previously carefully examined, and no such particles found; while in other cases it has appeared probable that the periosteum had carried fragments of bone away with it. M. Ollier considers that a 'subperiosteal blastema' exists naturally between the periosteum and bone, and that this is the source of the deposit.

The periosteum, however, although the most important, is not the sole agent in the reproduction of bone; so that it may be confidently expected that bone will be reproduced in healthy subjects, even though the periosteum be extensively destroyed; but the reproduction will not be so complete as if that membrane had been left. Such a process of reproduction may often be watched in cases where the soft parts have sloughed after scalp-wounds, and have left the cranium exposed.* The accident will often be followed by exfoliation from the surface of the bone; granulations then shoot up from the bony surface so exposed, and these are joined by others which advance from the soft parts in the neighbourhood: a fibrous cicatrix is formed which can be felt gradually hardening and ossifying. If an opportunity occurs for examining it after the lapse of some considerable time (say half a year), it will be found that the fibrous tissue of the cicatrix is ossifying at its deepest part, and scattered granules of bone will probably be met with at various parts of the cicatrix.

This process may go on even when the bone and periosteum have been removed by operation, as in the wounds of resection,†

* See Wagner, *On Repair after Resection of Bones* (New Syd. Soc.), Appendix, p. 241, for a case in which this form of reproduction is well described.

† See Wagner, *op. cit.* p. 156.

but is much more active when previous inflammation has been excited in the medullary tissue, and surrounding soft parts, during the action necessary in order to eject a piece of necrosed bone. In fact, speaking generally, the process of reproduction after necrosis is beyond comparison more active than after injury or operation. Thus, when necrosis has preceded the operation, whole bones of the fore-arm have been removed, and yet a useful limb has been preserved.

In a case which I had an opportunity of seeing, in which Mr. Savory removed the entire shaft of the radius on account of necrosis, leaving the articular ends,* the bone had grown from each of these ends to so great an extent that in eight months after the operation there remained an interval of only an inch and a half, and this appeared to be gradually, though slowly, contracting. This and several similar cases will be found quoted in Wagner's treatise above referred to, and may serve as an encouragement for boldness in our attempts to save limbs after extensive necrosis.

The exfoliation of diseased portions of bone, such, for example, as takes place so frequently in the course of extensive strumous disease, when a portion of the ulcerated surface is cut off from the rest, and therefore perishes, is not generally accompanied by any of that reparative effort which forms part of the process in a more healthy condition. The mere presence of necrosis in such affections is of comparatively little importance; possibly the removal of the dead part may be advisable (but only if it can be done without much violence), but the operation cannot be expected to cure the disease, since the necrosis is not its cause, but its effect. Nevertheless considerable improvement may, in appropriate cases, be expected to follow on the removal of the dead portion, which must always act as an irritant; and the exposure of the carious surface is also very frequently the starting-point of a more healthy action. Hence when bone is felt exposed and dead, it is usually advisable to endeavour to remove it, even although the surface around it is known to be carious.

The above description applies to necrosis in its more usual form. But besides this common chronic form of the disease, an affection which deserves the name of *acute necrosis* is sometimes, though not very often, met with. The destruction of all the soft parts surrounding a small bone, as a phalanx in acute neglected whitlow, will of course lead to the exfoliation of the

* See Wagner, op. cit. p. 243

whole of it, and to this affection the name of acute necrosis is sometimes given. There is nothing, however, in the pathology or treatment of such a disease to call special attention to the bone. The rapid and tensive inflammation threatens other parts of equal importance—the joint, the tendons, nay, in some cases even the skin—with destruction; and the free evacuation of the products of the inflammation is the only measure from which any good can rationally be expected. But there is a less-known class of cases in which larger bones are involved in rapid destruction, without known cause, or from causes apparently quite inadequate; and such cases involve not merely local mischief, but very grave danger to life. Many such cases of rapid necrosis are the result of that diffuse inflammation of the periosteum which has been described above; but in others which I have had an opportunity of seeing, I have failed to detect such a cause for the death of the bone, or indeed any cause to which so extensive and so universal an action could reasonably be ascribed.

Such a case was the following. A stableman was admitted into St. George's Hospital on account of disease in one foot. The history was obscure, but it seemed certain that little more than three weeks before his death the foot was comparatively well, as it was to an injury supposed to have been received two days before his admission, in running violently down the stable-yard, that the disease was attributed. There was oedema, swelling, and pain over the dorsum of the foot; and this condition was attributed to diffuse cellular inflammation, and treated by superficial incisions, which did not penetrate the periosteum. The man died, with symptoms of pyæmia, but no secondary abscess, twenty days after his admission. On examining the foot, all the tarsal bones were found loose, and grating on each other like stones in a bag; the cartilages between them had almost entirely disappeared. On section, the bones were of a dark-grey hue, and some slight trace of pus was seen here and there in the interior, but no such distinct indication of inflammation of the lining membrane of the cancelli as to deserve the name of osteo-myelitis; nor was the periosteum thickened, vascular, or separated from the surface of the bone by either lymph or pus in any appreciable quantity. The surfaces of the bones exposed by the removal of the articular cartilages were ulcerated, but not deeply. The bones were of their natural consistence.

Is such an affection as this amenable to any treatment? This seems doubtful, if it be conceded that cases of acute necrosis really exist in which the affection is different from diffuse periostitis. In the latter affection timely incisions may succeed, as has been already said, in checking the effusion and restoring the nutrition of the bone; but if the whole bony tissue be involved at once, what agency can be reasonably expected to restore it to health? It is clear that the main ques-

tion in such a case is, whether the patient's powers will endure the strain of the disease, so that the bone may be cast off, and he may have the chance of its reproduction, or whether amputation will give him a better prospect of life. But the prognosis of an amputation undertaken under such circumstances would be in the highest degree unfavourable, since the condition of system in which such grave results can follow from such trivial injuries leaves little prospect of bearing up against so serious an injury as the removal of a limb; and the tendency to pyæmia is so strong that it is impossible to say that that condition of the system may not be actually present, though latent, when the operation is done. It will therefore, in most cases, be judged better to support the patient's strength by a liberal allowance of tonics and opiates until the graver dangers have passed away; and then, if the usefulness of the limb is hopelessly destroyed, to remove it when the patient has rallied from the typhoid condition in which the disease commences. Incisions may not have the power of averting the death of the bone, but they ought to be made to an extent sufficient to liberate all tension, and that for two principal reasons—partly in order to avoid sloughing of the periosteum, and consequent destruction of the nidus in which the new bone is to be formed, partly to provide a ready way for the pus, which must form, to escape, and for the examination of the bone and its eventual extraction.

Acute necrosis, whether resulting from diffuse periostitis or not, may be treated by the extirpation of the whole bone so affected, a very free incision being made through the periosteum, which will be found completely separated from the bone, and the bone being, if necessary, divided by a chain-saw passed underneath it. In cases of necrosis of the entire diaphysis of a long bone, a slight twist with the lion-forceps will detach the dead portions from the epiphysial lines above and below. In this way I removed successfully the whole shaft of the tibia (seven and a half inches long), at the age of ten, one month after the commencement of acute periostitis, with very successful results.* I think, when we have clear reasons for believing that

* *Lancet*, 1866, vol. i. p. 340. See also *Surgical Treatment of Children's Diseases*, 2nd edit. p. 391, et seq.; where other instances under my own care are related; also a case by Mr. Joseph Bell, *Brit. Med. Journal*, May 2, 1868, very similar to a case of mine in the femur, but more extensive.

the necrosed bone will be found loose, its early removal is most desirable, and liberates the patient from great dangers, both in the present, from the acute surgical fever kept up by the irritation of the diseased bone, and in the future, from the risks incident on the numerous and severe surgical operations which will probably be necessary for the removal of so extensive a sequestrum. I do not recommend the operation when a portion only of the diaphysis has perished, and has not yet separated. The old idea that it is necessary to wait in these cases for the formation of a periosteal sheath of bone, is sufficiently refuted by my cases and that of Mr. J. Bell, which show that even in so large a bone as the femur a great portion (and I do not see why not the whole, if such a case should occur) of the entire circumference of the shaft may be removed, and the limb be left perfectly flail-like after the operation, and yet entire consolidation and perfect usefulness of the limb may finally result.

CONSTITUTIONAL AFFECTIONS.

Scrofula in bone.—There are two forms in which scrofulous affections of bone are met with : viz. either a deposit of tubercle, or a low inflammation of the osseous substance ; and there is good reason for considering the former as a consequence, or effect, of the latter. Let us, then, first consider the peculiar or distinctive characters of scrofulous inflammation of bone.

A scrofulous bone, when examined in the early stage of the disease, is soft, light, and oily ; sometimes more highly charged with blood than natural, and occasionally (though only rarely) presenting a deposit of tubercle in its interior. Bones in this condition are constantly met with after the removal of scrofulous joints : the substance of the bone is easily cut with a knife, and the cancelli are large, and charged with a red jelly-like mass of débris. The inflammation readily passes into ulceration, or caries, and the bone then exhibits on its surface a number of minute pits, or depressions, from each of which the ulceration extends, so as to communicate with those around, until an extensive worm-eaten surface is exposed,* soft and rotten on its exterior, bleeding readily, and giving exit to a foul-smelling ichorous pus, in which pieces of decomposed bone can be felt, as gritty particles under the fingers. The periosteum becomes

* For the appearance of scrofulous ulceration in the macerated bone as contrasted with simple ulceration, see Figs. 189, 190, p. 752.

detached and thickened, and is gradually converted into a gelatinous mass of granulations.

The minute changes in the ultimate tissue have been ably described by Dr. Black, in a series of researches to which my own observations lead me to assent. The cancelli are dilated, and they, as well as the lacunæ and canaliculi, are filled with exudation. Occasionally, minute projections of bone from the walls of the cancelli indicate an attempt at the reproduction of bone, and that healing by sclerosis which has been already described as one of the usual events of healthy inflammation. The leading features, then, of the pathological anatomy of strumous inflammation are the same as those of otitis in general; and the only distinctive anatomical peculiarity consists in the nature of the exudation, which chokes up the canals of the bone. Dr. Black has given several analyses, tending to establish these four conclusions: that tuberculosis gives rise (1) to a considerable increase of fat in the diseased bone; (2) to a large diminution of the salts of lime; (3) to a diminution of the organic matrix; (4) to an increase in the soluble salts. For the details of the analysis, the reader must be referred to the original treatise.* They serve to illustrate the fact, that strumous is distinguished from common inflammation by the softness, lightness, and oiliness of the affected bone; to which may be added, the greater extent of diffusion of the morbid changes.

The superficial caries, during the mere presence of which, the bone, if the affection be not very extensive, is possibly still in a curable state, spreads gradually inwards, and then the condition of the bone passes beyond the possibility of repair. Large abscesses form, and the whole cancellous extremity, or the whole bone if it be one of the cuboid bones of the tarsus or carpus, is converted into a cavity bounded by a thin shell of osseous matter, and containing bony substance, either in mere débris, or so soft that it will crumble away in maceration. These abscesses are seldom accompanied by that thickening of their walls from periosteal deposit which takes place in simple otitis; still, at some distance from the seat of profuse suppuration, fresh deposit is sometimes found thickening the bone, or producing ankylosis in joints which enjoy little motion. Necrosed portions of larger or smaller size are often found, but

* *On the Pathology of Tuberculous Bone*, p. 32. Edinb. 1859.

no 'sequestra' in the proper sense of that term, as signifying necrosed portions invaginated by new bone.

Such are the anatomical characters of scrofulous inflammation of bone. The other common development of that diathesis in the osseous system consists in the deposit of tubercle, either circumscribed or diffused. Circumscribed tubercle * (much the rarer form) seems most common in the skull, deposited on the outside of the bone beneath the periosteum (the strumous node); and next to this its favourite locality is in the cancelli of the joint-end of some bone, generally the tibia. No inconvenience seems to be produced by such tubercle till it softens; and then, if situated in the articular end of a bone, it usually makes a passage into the neighbouring joint and destroys it; if on the skull, the softening of such a tubercle forms a cachectic abscess difficult to heal, bordered by indurated cellular tissue, with cold, bluish edges, and leading to exposed and roughened bone, which, however, has not the peculiar feeling of necrosis, and is not at first dead, although it is liable to become so. The deposit of diffused tubercle is more common in the shafts of the long bones. It fills up the cancelli, appearing as a nodulated, or granular, yellowish mass of soft consistence, and extends frequently along the whole length of the shaft. My own impression is, that this diffused tubercle less frequently and less rapidly softens than the circumscribed; but exact information on this point is wanting. It should be remembered that when the shaft is attacked by this or any other form

* Tubercle in bone is, in any view of the case, rare. Rokitsansky's statistics, referred to in vol i. p. 357, give a low place to the bony system as a seat of tubercle; though they place the bones and periosteum considerably above the testicle and epididymis, which is hardly in consonance, I believe, with the experience of most surgeons. But the nature of the deposit generally spoken of as tubercular is the subject of much difference of opinion among different pathologists. Dr. Wilson Fox says: 'These limitations of tubercle have proceeded so far, that, if the exclusion of the different forms from the category of tubercle, proposed by various pathologists, were simultaneously carried out, tubercle would—not unfortunately, cease to exist—but would certainly have no longer any place in our nosologies; for nearly every pathological product hitherto ranked under this title, from the grey granulation, to the yellow granulation and the cheesy infiltration, is by some authority or other excluded from the category of tubercle.'—*Artificial Production of Tubercle*, p. 22. My opinion is, that many of the deposits which are usually regarded as tubercles in bone, are masses of inspissated pus mingled with other inflammatory products; and that, rare as tubercle in bone is generally said to be, it is in reality still rarer.

of disease, the extremities usually escape, and *vice versâ*—a matter of great importance in the treatment of diseases of the joints.

It has occurred to me, though hitherto only on two occasions, to meet with a particular form of ulceration, which was in one case certainly,* and in the other probably, connected with scrofula.

Numerous pits were found on the articular surface, varying in depth, but confined to the epiphysis, with sharp edges, and curdy purulent contents. Their openings into the cavity of the joint were cleanly punched out of the cartilage, and all the cartilage around was quite healthy. A few small granules of bone were met with among the contents of the cavities. In one of the cases, when the bones were examined, there were found several spots of vascular and softened tissue beneath the surface of the bones, evidently the commencement of similar pits. There was no trace of tubercle. The thigh was amputated, and the patient recovered for a time, but soon died of phthisis. In the other case, the patient, a boy under the care of Mr. Thomas Smith, recovered after excision of the knee, and remained long afterwards in good health.†

I believe this pitting or spotted ulceration of the articular ends of bones to be one of the forms of scrofulous disease, and to be indistinguishable from its other forms before dissection. It presents a very favourable condition for resection, from the strict limitation of the disease to a very slight depth below the surface.

Symptoms.—Of the symptoms of scrofula in bone little need be said here. The general symptoms of the diathesis, added to an indolent swelling of some bone, lead to a diagnosis not to be mistaken. The swelling is composed partly of the engorged soft tissues, and partly occasioned by real enlargement of the bone. The colour is usually white and pasty,‡ and the swelling indolent; but sometimes, when the inflammation is higher than common, and suppuration imminent, redness and pain may be present. When suppuration has been effected, the pain generally subsides, and the functions of the part are more or less completely regained, even when the bone is destroyed to a considerable extent.

Treatment.—The treatment of scrofula in bone offers little that is peculiar. For local treatment, perhaps the most im-

* A notice of this case will be found in *Path. Soc. Trans.* vol. x. p. 217.

† This is figured in the work above referred to, *On the Surgical Treatment of Children's Diseases*, p. 488.

‡ The 'white swelling' of old authors was named from strumous disease of the joints, though many other affections came to be included under the term.

portant indication is to keep the part at rest by splints and bandages during the prevalence of inflammation. Local depletion should be cautiously used while there is pain, tenderness, and superficial redness, or the part may be enveloped in a large warm poultice or fomentation. When inflammation is not apparent in the soft parts, but there are signs of its presence in the bone, it will be necessary to use counter-irritation by caustics or blisters; or in less severe and more chronic cases by means of the tincture of iodine, or other stimulating application. When irritation has subsided, pressure by means of strapping will be found very serviceable, both in ensuring rest and in promoting absorption, and the local action of mercury (Scott's bandage) may be combined with this. By these simple measures, with judicious constitutional treatment, most of the cases of strumous inflammation, which are seen before the occurrence of suppuration, will be brought to a favourable issue.

When the suppuration is once established, it is better to procure exit for it by small incisions, and to use every precaution to prevent the denudation of fresh portions of bone. The question, however, of the early or late opening of abscesses connected with strumous bone is one on which a good deal of difference of opinion very naturally exists, and which is best determined in each individual case. If such abscesses are allowed to go on increasing, the soft parts may be extensively undermined, the disease may extend to fresh bones, and an opening may form in a disadvantageous situation. If opened early, the cavity may be attacked with inflammation, which, if the abscess be large, may even prove fatal. If, however, the abscess be near an important organ, as a joint or serous cavity, then undoubtedly no time should be lost in evacuating it. Large openings should be avoided; but the introduction of a piece of lint, or a drainage-tube, will keep the discharge flowing; or the abscess may be emptied by means of a trocar from time to time, and the access of air thus effectually precluded. When the bone is exposed through the opening of an abscess, its condition should be thoroughly investigated, once for all, with the probe, in order to judge of the necessity for operative interference; but nothing is more mischievous than repeated meddling with diseased bone. The general indications for operations upon bones affected with strumous caries, and the form of operation indicated, will be the same as in caries

depending upon other causes ; but the prognosis will be less favourable than when the constitution is unaffected, and therefore operations should be undertaken with more caution. Operations on these cases will usually succeed or fail according as scrofula has attacked the viscera or no, and according to the extent of its diffusion through the system ; but even after a successful operation the patient is by no means secure against a relapse in some other part.

For the general treatment the reader must be referred to the essay on SCROFULA.

Syphilitic affections of bone.—The chief phenomena of the syphilitic affections of bone have been already spoken of summarily under the head of Tertiary Syphilis (vol. i. p. 482) ; it will therefore only be necessary here to go a little more into detail as to the anatomy of bone affected by syphilis, and the means by which the disease is to be diagnosed. As the general treatment of syphilis has been laid down in Mr. Lee's essay, only the local treatment of its manifestations in the osseous system will be dwelt on here.

Syphilitic affections are those in which the existence of a chronic limited inflammation of the periosteum alone is most clearly proved, if, indeed, such inflammation be not peculiar to syphilis. Strumous nodes (as we have just remarked, p. 780) are formed by scrofulous matter confined between the carious bone and its periosteum, and are due to an affection of the bone ; but the true node, that which follows syphilis, is caused by the effusion of lymph between the bone and periosteum, and is due to inflammation of a limited portion of the deeper layers ('subperiosteal blastema') of the latter. Hence it is of a different signification from that of a strumous abscess ; for while the latter is merely a consequence of diseased bone, and necessarily involves corresponding loss of substance and the slow processes by which alone an ulcer (and more especially a strumous ulcer) in bone can be healed, the syphilitic node is itself the starting-point of the disease in the bone, and if early and properly treated, the whole organ can be restored in a short time to a state of health. But although in a node the inflammation is usually limited to the periosteum, it is not always so. Numerous preparations show thickening of the substance of the bone beneath nodes,* proving the implication of the deeper structures,

* St. Thomas's Hospital Museum, series c, No. 54.

and therefore a state of disease which, though still curable, may be expected to be more obstinate than mere periosteal effusion ; and if the skull be examined in the situation of a node, some roughening of its outer table may generally, perhaps always, be discovered. The progress of nodes, when they are not absorbed under appropriate treatment, is in one of two directions : either the subperiosteal effusion ossifies, or it softens and gives rise to caries, accompanied usually by suppuration. The former event is commoner on the tibia, the latter on the skull. The indisposition of the pericranium to form new bone is a very well-known fact in pathology, nor am I aware that the formation of new bone in syphilitic nodes of the skull has ever been proved, though new bone may be sometimes found deposited on the outer table of the skull in the neighbourhood of large ulcers ;* in nodes of other flat bones also, ossification, if it occurs, is rare. Many nodes appear so hard as to be pronounced osseous ; but the feeling is often deceptive, since the tense and thickened periosteum raised by semi-solid effusion gives a sensation hardly to be distinguished from that of a bony swelling. Therefore, in a hard node which is of no long standing, treatment for its removal may be confidently recommended, and all the more if the swelling be situated on a flat bone. On the tibiæ nodes are prone to ossify, and then the deeper ossified part remains as a permanent irregularity on the surface of the bone ; but the unossified portion may often be dispersed by appropriate measures. When a node softens, and the question occurs whether pus has formed, the case ought to be carefully examined, in order if possible to determine the point. The principal indication of the presence of pus is the shining, tense, and thinned condition of the skin. It is important to obviate more destruction of the skin than is inevitable on the bursting of the abscess, since such sores are very difficult to heal, and in some cases appear incurable. The best way is to make a very small puncture, and close it after drawing off the pus. Frequently, under the proper treatment, the soft parts will adhere again to the bone with very slight or no exfoliation.† It is

* Even here it is in most cases doubtful whether the deposit has been formed outside the skull, or whether the thickening is not produced by deposit within the diploë expanding the outer table ; for deposit in the diploë is exceedingly common. See below on the 'tuberculated' form of syphilitic ulceration in bone.

† See Parker, *Modern Treatment of Syphilitic Diseases*, 4th ed. 1860, p. 291.

especially in these cases of abscess communicating with the surface of a bone that I have found the treatment by carbolic acid, recommended by Professor Lister, most successful. In several cases under my own care where I have had either positive proof or the strongest reasons for concluding that the abscess was connected with diseased bone, I have found the abscess heal readily, and without exfoliation. Many others have also been put on record by Professor Lister and other surgeons. Very commonly, however, the formation of periosteal abscess after a node is followed by the exfoliation of most of the subjacent bone. Syphilitic nodes are usually preceded, and always accompanied, by more or less of dull aching pain in the bone, especially liable to exacerbations at night; or this 'syphilitic rheumatism,' as it is sometimes called (the *douleurs ostéocopes* of French authors), may be the only symptom referred to the osseous system during the progress of the secondary affection. Mr. Parker* is inclined to refer the pain to a syphilitic inflammation of the medullary membrane.

When the syphilitic cachexia is further advanced, the whole bone or a great part of it may be diseased through its entire thickness, leading to chronic osteitis, and terminating in seclerosis, or what is sometimes called 'hypertrophy' of the whole thickness of the bone. I am not aware of any distinction which could be drawn between such instances of chronic inflammation and those arising from non-specific causes, except that which is founded on the presence of concomitant and preceding syphilitic symptoms in other organs.

Still more grave and more obstinate developments of tertiary syphilis in the bones are those carious and necrotic affections (ulcerative or gangrenous) which so often attack the skull, the bones of the face, and the superficial long bones, in persons much reduced by excesses, or by the injudicious administration of mercury. In former times, under the horrible system which prevailed in the 'foul wards' of the great hospitals, where every person labouring under any disease supposed to be caused by promiscuous intercourse was compelled to take mercury to salivation, the ravages of syphilis on the bones were dreadful; and it is to this system that we owe many of the preparations of syphilitic caries and necrosis preserved in our museums.

* Loc. cit.

But there seems no reasonable doubt that such affections do also occur in persons who have never taken mercury,* especially when the disease has been allowed to go on unchecked, and the constitution is at the same time enfeebled by alternations of debauchery and hardship, as is the case sometimes with sailors, and more frequently with prostitutes.

The diagnosis of syphilitic affections is usually easy from the history of infection and the presence of other symptoms ; but it may in some cases be obscured by the patient's unwillingness or inability to reveal the history of the original disease. Thus the pains in the bones may be referred to rheumatism ; but here the diagnosis can in most cases be easily established by observing that rheumatic pains in the bones are generally accompanied by affections of the thick fibrous structures (muscles or fasciæ) and of the joints ; or, if the rheumatic affection be more acute, the urine and sweat will probably furnish indications of the nature of the disease. When nodes have made their appearance, the diagnosis is usually easy, the only question lying between syphilis and struma, since rheumatic periostitis is, as we shall see, more diffused. In the absence of history, the concomitant symptoms will guide us while the skin is unbroken ; and after pus has made its way to the surface, some assistance may be derived from the nature of the secretion. Syphilitic caries and necrosis (as has been observed in the essay on SYPHILIS) are not primary affections of the bones, but are the result and termination of nodes, or of inflammation of the bones, or of ulcerative affections of the soft parts around the bone, as in the palate, and therefore have been preceded by a long course of symptoms, during which the diagnosis is usually established. If not, it rarely presents any difficulty, since the traces or the presence of other symptoms of constitutional syphilis can hardly fail to be recognised.

An interesting comparison has been made between the forms of syphilitic ulceration in bone and those of syphilitic eruption on the skin. Specimens of rounded ulcers may sometimes be met with, especially on the skull-cap, which bear a strong resemblance to the rupial ulcers so frequent in an advanced stage of constitutional syphilis. A small round spot of ulceration is seen, where the surface of the bone is worm-eaten from the presence of numerous minute depressions, and in some cases

* See Parker, *op. cit.* p. 281.

the bone around this worm-eaten central portion is marked by arborescent grooves, the traces of increased vascularity. Later on, a circular trench is marked around the worm-eaten spot; and as this widens and deepens, it undermines and finally chisels out the piece, which separates as a sequestrum, and then the bone scars over, leaving a rounded depression, much larger than the original spot, the surface of which is rather glazed and a little vascular, and the bone below it a good deal hardened. In well-marked specimens, these *annular* ulcers, as they are termed by Mr. Paget, (Fig. 192), look very charac-

FIG. 192.

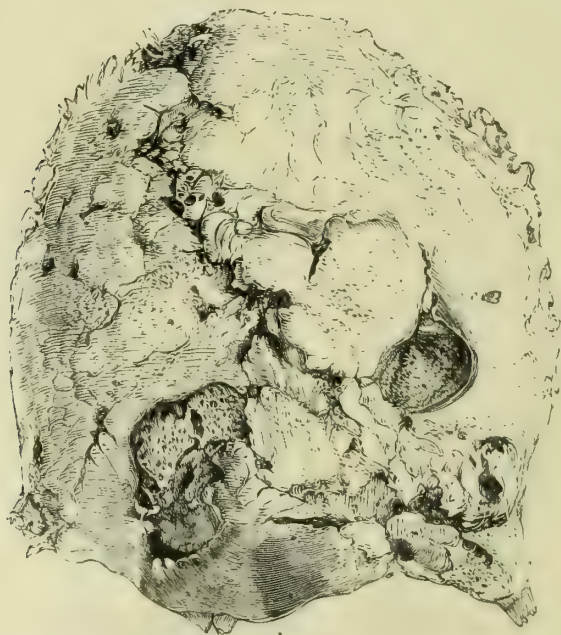


Syphilitic ulceration of the annular variety. (Museum of the Royal College of Surgeons, No. 635.)

teristic, but in less advanced cases, especially before the surrounding trench has formed, or again at a late period when cicatrisation has obliterated some of the more distinctive characters of the ulcer, it seems impossible to distinguish it from a scrofulous or other lesion. The other characteristic form of syphilitic ulceration is the *tuberculated* (Fig. 193), which appears to commence by a tubercular thickening of the external wall of the bone, recalling the syphilitic tubercle so common on the skin of the face, &c., and due not to periosteal

deposit, but to chronic inflammation of the compact tissue itself. This inflamed bone soon becomes dotted over with numerous little pits or depressions, which coalesce and form ulcers, usually oval or round, penetrating deeply into the interior of the bone. Besides these, Mr. Paget has described a third form of syphilitic ulceration, the *reticulated* (Fig. 194) in which the disease appears first to show itself in the form of a network of periosteal deposit, which is liable to perforation by ulcers subsequently forming and assuming the annular type, of which

FIG. 193.



Syphilitic ulceration of the tuberculated variety. (Museum of the Royal College of Surgeons, No. 632.)

latter, therefore, the above may be regarded as a variety. Of the two kinds of syphilitic ulcer, the annular appears to me the more characteristic; but I do not believe that either is so distinctive of the disease as to enable us, with anything like certainty, to infer the previous constitutional affection from examination of the affected bone; nay, I have known pathologists of the greatest experience refuted in such attempts by the subsequent discovery of the history of the preparation.

The accompanying figures represent characteristic examples of these various forms of syphilitic ulcer; and by comparing

them with those of simple, strumous, rheumatic and malignant ulceration, which will be found at pp. 752, 793, 813, the reader will be enabled to see at a glance much better than by verbal description, the differences of these affectionous as shown on the macerated bone.

Any of these forms of syphilitic ulceration may affect the bone so deeply as to penetrate its whole thickness. Thus in the

FIG. 194.

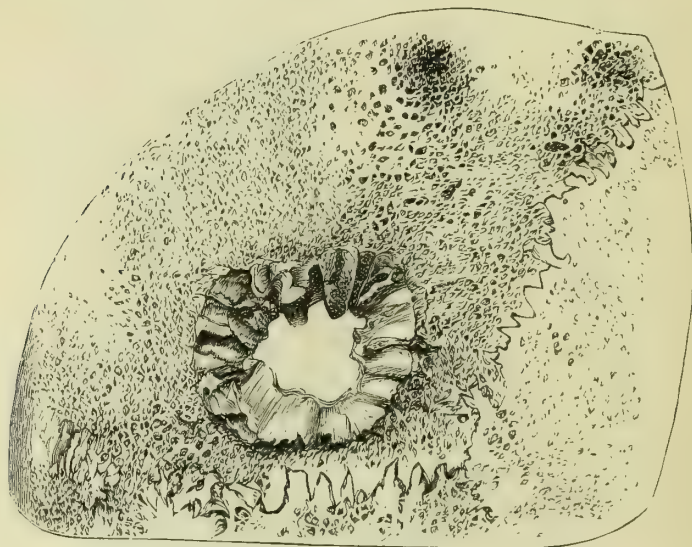


Syphilitic ulceration of the reticulated variety. (Museum of the Royal College of Surgeons, No. 630.)

Museum of St. Barthomolew's Hospital is a specimen (A 34) of a clavicle in which the bone has given way (probably after death) in consequence of penetrating ulceration attributed to syphilis. Spontaneous fracture of a long bone, however, from penetration by a syphilitic ulcer is extremely rare; while penetration of a flat bone, especially of the cranium, is still a pretty frequent circumstance, and used to be an ordinary result of syphilis. In the greater number of such cases no serious mischief follows;

the dura mater is exposed on the separation of the necrosed central part of the ulcer, but soon gets covered over, so that its pulsations are no longer visible, and in a little while the gap will be filled up by fibrous tissue. In rare cases, however, pressure upon the brain is produced either by matter confined between the skull and dura mater, or by ulceration laying open a branch of the middle meningeal artery and causing hæmorrhage.

FIG. 195.



Penetrating syphilitic ulcer. (Museum of the Royal College of Surgeons, No. 636.)

Treatment.—The treatment of constitutional syphilis has been already described, and it has been shown that at one period or other of the disease a prolonged and sufficient exhibition of mercury will be necessary for cure. To this general rule the affections of bone form no exception, for although some of them are usually found accompanied by so profound a cachexia, so complete a prostration of the whole system, that mercury is inadmissible, it will also be found that such affections do not admit of cure. Iodide of potassium often acts, however, upon the earlier affections of the bone and periosteum like a charm, and the symptoms soon disappear; but those whose experience in the treatment of syphilis is most extensive*

* See vol. i. p. 405; Parker, *op. cit.* p. 289.

believe that the improvement is not permanent, and that for the entire eradication of the constitutional affection a mild but prolonged course of mercury (for which the calomel vapour-bath is the most appropriate agent) ought to be insisted on. The local treatment of bone inflamed from syphilis presents several interesting questions. Nodes will usually be benefited by blisters, or if the bone seem to be more deeply affected, by the persevering use of mercurial ointment, strapping with the empl. hydr. cum ammoniaco, iodine paint, &c. But when the pain in the inflamed bone is constant and very distressing, it is quite justifiable to divide the periosteum by a free incision; and then, if nothing is found to account for the tension and to hold out a prospect of its relief, a trephine may be applied to the bone itself, and its medullary canal laid open.* If symptoms of cerebral disturbance make their appearance in the course of ulceration of the cranium, the application of the trephine has sometimes been successful in preserving life; but, on the other hand, it is not to be denied that it has sometimes produced or hastened death. The proverbial obscurity of all cranial affections ought, I think, to make us cautious in adopting so extreme a measure as trephining the skull, unless in a patient whose state is otherwise evidently hopeless. Epileptic convulsions, even with slight symptoms of paralysis, are hardly a sufficient indication for the operation; but the experience of Mr. H. Lee† has shown that in some cases the removal of the diseased bone has been followed by the healing of ulcers which had previously been obstinate; and it seems that the removal of the outer table only, when it is dead, and appears to be keeping up irritation, is a safe practice.

The treatment of fissures and defects of the palate from syphilitic necrosis will be found discussed in a subsequent essay.

Rheumatic and gouty affections of bone.—It is extremely difficult to be certain of the existence of any specific affection of bone due to the rheumatic diathesis. Rokitansky, in his ‘attempt to determine the characters of the constitutional affections of bone, particularly the inflammations and caries, by

* Parker, op. cit. p. 283.

† *Proceedings of the Med.-Chir. Soc.* vol. iii. p. 283.

reference especially to the appearance of the bone after maceration,* doubts 'whether rheumatism gives rise to an inflammation that can be distinguished by any definite character of its products, or to any particular caries, however positively assertions be made on the point;' but there is no doubt that common osteitis is very generally produced by exposure to cold and wet, and other causes, which at the same time generate rheumatism, nor is there any reason whatever for questioning the universal opinion of persons of experience, that those who are the subjects of rheumatism are also those who are most prone to inflammation of the superficial bones, such as the skull, tibia, &c.

The disease now commonly called 'chronic rheumatic arthritis' or 'osteo-arthritis' is regarded by some authors of credit as originally a disease of the bone. In this work, however, it is considered as commencing in the soft tissues of the joint (see DISEASES OF THE JOINTS).

I would not be understood, however, to deny the existence of an affection which deserves to be called 'rheumatic osteitis.' The condition of the articulating extremities of the bones in cases of osteo-arthritis is very peculiar, and can hardly be explained by any theory except that of some constitutional peculiarity in the disease, since neither the age of the patient nor the mode of causation of the malady offers any constant features which can account for the singularity of the affection of the bone. That which is most characteristic in all those cases which appear to be rheumatic, is their very slow course, and the great length of time during which inflammation may be present without either caries or necrosis. In all rheumatic affections of the joints, and in many of those of the limbs, although it may be true that the complaint originates in the fibrous tissues, yet the bones will become involved if the disease lasts long enough; and in that case the principal features will be in the shaft of a long bone, extensive stalactitic or foliaceous laminated deposit from the periosteum, and sclerosis of the superficial portions of the bone; the medullary canal and the deep cancellous tissue being usually, if not always, unaffected. In the Museum of the Royal College of Surgeons, Mr. Paget has classed some specimens† as 'rheumatic ulceration,' in which, along with these appearances on the shaft of the bone,

* *Path. Anat.* (New Syd. Soc. Trans.) vol. iii. p. 202.

† Nos. 626, 627, 627 A.

ulceration is seen invading the newly-formed periosteal deposit. One of these preparations will be found represented in Fig. 196. In any case, the occurrence of nodes, and more or less of inflammation of the wall of superficial bones in cases of rheumatism, is a sufficiently probable event; but it is a complication which must be treated on general principles. The nodes do not affect the limited extent and rounded outline of those due to syphilis, but are irregular swellings of the periosteum, involving a considerable extent of the surface, and probably some of the thickness of the bone.

The most characteristic effects of rheumatism, however, are displayed upon the articulating extremities; but as this disease will be found fully described in the essay ON DISEASES OF THE JOINTS, it will not be necessary to say much about it here.

The chief features which are distinctive of rheumatic inflammation of the bones are, the extensive deposit of bone in the fibrous structures around, the condensation and thinning of the shell of the bone, the rarefaction and partial absorption of its interior, and the consequent change of shape which parts containing much cancellous tissue, such as the articular heads and necks of long bones, suffer. In the articular disease the new bone is found, to a great extent, in the ligaments and other tissues distinct from the periosteum, and thus forms what Dr. Adams calls 'additamentary bones,' which have been so often mistaken for portions fractured off the bony prominences, near which they may be situated, and remaining ununited. I shall adduce some reasons for believing that many of the specimens in which portions of bone have been found near the shafts of long bones, but movable upon them, and which have been thought to be instances in which exostoses had been fractured at their base, may be of the same nature.

FIG. 196.



Rheumatic ulceration of bone.
(Museum of Royal College of
Surgeons, No. 627.)

As to the treatment of the rheumatic affections of bone, nothing need be said here, since all that is necessary to add to the general treatment of osteitis will be found in the essay on DISEASES OF THE JOINTS.

I have nothing to say about the affections of the bones in gout. The deposit of lithate of soda is sometimes found in the interior of the bones in inveterate cases, as well as on their exterior; but its importance is quite secondary. Stromeyer* alludes to a case in which nearly all the bones of one side of the body were hypertrophied in a patient who had long suffered from gout; but no opportunity occurred of examining the bones affected.

Mollities ossium.—The peculiar condition of the bones which is known by the name of mollities ossium, or malacosteon, is one which is very rarely met with. In the female pelvis, as a cause of difficulty in parturition, it is less rare than under other circumstances, and demands the special attention of the obstetric surgeon, involving, as it does, some of the gravest questions which are to be solved by that branch of our art. These questions, however, which have reference to the altered relations between the deformed bones of the pelvis and their contents (especially the gravid uterus and foetus), are not within the scope of the present work. We have only to consider the disease in its pathology and general surgical bearings.

The pathology of mollities is far from being satisfactorily established; and there can be little doubt that this has arisen, in great part at any rate, from the fact that authors have confounded several different conditions under the same name. Some, indeed, make no distinction between mollities and fragilitas ossium; while others regard mollities as an affection allied to, if not identical with, rickets.

The disease which appears best to deserve a separate description under the name of mollities, is marked by the following characteristics. Several bones are usually affected at the same time. The portions of bone attacked are uniformly softened throughout the whole extent of the disease. The disease, however, does not in all cases affect either the whole length or the whole thickness of the bone, and if the specimen be examined at an early period, the outer shell is often found to retain its

* *Handbuch d. Chirurgie*, vol. i. p. 442.

natural consistence.* When the whole bone is affected, it can be readily bent, and resembles, in extreme cases, as Dr. Ormerod † remarks, rather a portion of fatty matter enclosed in a case of periosteum than a bone. If the cancellous tissue (in which the disease appears to originate) be examined, it is found that the cells are enlarged, sometimes to such an extent that the whole bone is expanded, and are filled with a peculiar reddish gelatiniform matter, in which, on microscopical examination, much fat and oil can be discovered, together with blood-discs. Besides these (which are the common products of any degenerative change), certain peculiar nucleolated nuclear bodies have been described by Mr. Dalrymple.‡ Instances of bones affected with mollities do, however, occur, in which the amount of fat is not greatly increased. Thus in a specimen in Guy's Hospital Museum (No. 1004⁸⁸), taken from a case reported by Mr. Solly, in the 27th volume of the *Med.-Chir. Trans.*, it is said that the diseased tissue consisted simply of an organic matrix, with little earthy matter, and containing little fat. Cases like these show that it is impossible to describe mollities as simply a fatty degeneration. Degeneration of some sort is, however, always present; and as this advances, it involves the compact walls of the bone, and then the disease becomes for the first time recognisable, by the symptoms which will be immediately described. At a later period, the whole bone is found to be involved, and becomes a mere bag of soft matter enclosed in the periosteum, which, perhaps, may be somewhat thickened, but it does not appear that any further destruction of the bone itself occurs. It is merely converted into a soft, generally oily, material, which crumbles away on maceration, but which seems capable of resisting absorption for an unlimited period during life.

The symptoms of mollities are sufficiently striking in a well-marked case to attract immediate notice, however obscure may be the real nature of the constitutional affection. The patients

* As in Dalrymple's case, referred to below.

† *Brit. Med. Journal*, Sept. 10, 1859.

‡ *Dublin Quarterly Journal*, 1846, p. 85; see also *Path. Soc. Trans.* 1846-7, p. 148. It is said that in bones affected with mollities, lactic acid and lactates are to be discovered, and that this lactic acid promotes the solution and absorption of the phosphate of lime. The fact, however, appears doubtful. See Drivon, *Arch. gén. de Méd.* 1867, vol. x. p. 608.

are, it is said, usually females,* and generally past the middle period of life. Repeated pregnancy appears to act as an exciting cause of the disease, and may, perhaps, account for the greater proportion of females.

The disease appears to be, in some cases at least, hereditary. Thus, in the history of Dr. Ormerod's patient, referred to above, it is stated that both the son and daughter were subjects of the same affection. Sometimes pain is complained of in the affected bones for some time before the nature of the disease becomes manifest; in other cases, however, the deformity induced by gradual softening of the bones is the first symptom noticed. When this softening has proceeded far enough, the bone gives way gradually, if it has been equably and thoroughly softened, so as to yield, and become merely deformed; but if the softening has been confined to the internal part of the bone, and the thin outer shell has been left solid, and therefore brittle, spontaneous fracture (or, more correctly speaking, fracture from very slight causes) is liable to occur. The former class of cases, in which the bone bends without breaking, are those in which mollities is most characteristically marked, since spontaneous fracture preceded by pain in the bone is also a feature of malignant and other diseases of the osseous system. In such extreme cases of mollities, the limbs become distorted in the strangest way, so that the thighs have been known to bend till one of the feet touched the head; and from the softening of the vertebral column and bending of the limbs, the stature is very considerably diminished. The constitutional cachexia is often not very strongly marked, and patients will live in this condition for an indefinite period, bedridden from the weakness of their limbs, and the loss of the firm points from and to which the muscles act, but with sufficient mental and constitutional vigour. The cause of death appears generally to be simple exhaustion; or failure of vital powers, like what takes place in extreme old age (in fact some of these patients do not die till the extreme of life); † or sometimes functional disturbance, induced by the altered relations of the viscera, and the pressure to which, from various causes, they are subjected. Not un-

* I do not find quite so great a disproportion between the sexes as is implied in the descriptions given by some authors. Of ten cases of true mollities taken at random, six were females, and four males.

† See the cases mentioned in the Catalogue of Guy's Hospital Museum, Nos. 1044⁶², 1098⁵⁰.

frequently, however, the patient does not die of the disease at all, but, having lived under its influence for many years, is carried off by some totally different complaint.*

With these symptoms it is not surprising that this disease should have been claimed as merely a rarer form of several better-known affections of bone, to all of which it bears some resemblance, however little they may seem to bear to each other. Some authors † consider mollities to be merely fatty degeneration, or atrophy of bone; others regard it as rickets attacking the adult; while many class it with cancer. Now each of these opinions has a basis of probability, and it is very possible that many of the cases of so-called mollities might with greater propriety have been entitled 'atrophy' of the bone. Of this Mr. Curling's case appears to have been a good instance; and the difficulty which some authors have expressed in distinguishing between mollities and fragilitas ossium ‡ appears to have arisen from their having compared together cases in which there was no real difference, and where the name mollities had been given to simple atrophy.

The connection between rickets and mollities appears, at first sight, a very close one, on account of the bending of the bones, and liability to fracture from slight causes, which characterise both. Some patients, also affected with undoubted mollities, have suffered in their youth from rickets.§ Still, if we consider the question attentively, the differences between the two affections far exceed their resemblances. Rickets is an affection of early life, closely allied to scrofula in its causation and in its cure; it is peculiarly amenable to treatment; and under favourable circumstances the constitutional cachexia, which is its essence, readily disappears as the child grows. Mollities hardly ever makes its first appearance till after middle life; and, even in those cases where the patient has been rickety, not till long after the cachexia of that disease has subsided; it shows no alliance with scrofula, and is not amenable either to the remedies for that disease, or, as far as is known, to any other remedies,

* Thus in Dr. Ramsbotham's case (*Path. Soc. Trans.* 1846-7, p. 148) the patient died of pneumonia, after suffering for more than six years from mollities.

† See Mr. Curling's paper in *Med.-Chir. Trans.* vol. xx. p. 356.

‡ It would be well if the term fragilitas ossium were allowed to become obsolete, since it only describes a symptom common to several affections.

§ This was the case with Dr. Ormerod's patient above referred to.

but pursues its career steadily, unaffected for good by any medical treatment.

In the latter particular, as in several of its other features, it bears a far stronger resemblance to cancer. In fact there can be little hesitation in classing some specimens preserved in museums as mollities under the head of diffused cancer; and, conversely, in recorded cases of cancer, some of the bones have been found in a state closely resembling, if not identical with, mollities.

Thus in a case of secondary cancer in the spine and other parts, after removal of scirrhus of the breast, related by Mr. Cæsar Hawkins,* it is noted that 'the centre of the neck appeared a little sunk forward, as if the upper vertebræ had been depressed in that position;' and the anatomy of the affected bone is thus described: 'The body of the fifth cervical vertebra was very irregular on its surface, and was softened throughout, with much enlargement of the cells of the cancelli, which were filled with a sanguineous pulpy fluid; the two adjoining vertebræ showed a lesser degree of the same morbid structure.'

But, allowing that many of the recorded cases of mollities may be referred to simple atrophy, and some of the others to cancer, there can still be no doubt of the existence of an independent disease to which that name is peculiarly appropriate.

In one such case recorded by Dr. Bence Jones,† the leading feature was the peculiar condition of the urine. This attracted attention, together with the state of the patient's general health, long before any alteration in the bones was apparent; in fact no alteration in them was discovered till after death. The peculiar substance contained in the urine appears to have been closely allied to albumen. Dr. Bence Jones's conclusions on this subject may be quoted here: '66 97 parts of this hydrated deutoxide of albumen were passing out of the body in every 1000 parts of urine. Hence, therefore, there was as much of this peculiar albuminous substance in the urine as there is of ordinary albumen in healthy blood. So far, then, as the albumen is concerned, each ounce of urine passed was equivalent to an ounce of blood lost. The peculiar characteristic of this hydrated deutoxide of albumen was its solubility in boiling water, and the precipitate with nitric acid being dissolved by heat, and re-formed when cold. By this reaction a similar substance in small quantity

* *Med.-Chir. Trans.* vol. xxiv. p. 45. See also a case of cancer of the bones after scirrhus of the breast, described by the author in *Path. Soc. Trans.* vol. xi. p. 219, in which some of the ribs were perfectly flexible. In examining a case of well-marked cancer of the pelvis, I have found a condition of the innominate bone bearing an almost equally close resemblance to mollities.

† *Phil. Trans.* vol. lxvi. p. 55. This is the same case as Mr. Dalrymple's, already referred to—the paper in the *Philosophical Transactions* containing the account of the peculiar substance found in the urine.

may be detected in pus, and in the secretion from the vesiculæ seminales. This substance must be again looked for in acute cases of mollities ossium. The reddening of the urine on the addition of nitric acid might perhaps lead to the re-discovery of it; when found, the presence of chlorine in the urine, of which there was a suspicion in the above case, should be a special subject of investigation, as it may lead not only to the explanation of the formation of this substance, but to the comprehension of the nature of the disease which affects the bones.'

These cases, then, of what we may call true mollities, are distinguished both from atrophy and from cancer by special characters: from simple atrophy by the existence of vitiated secretion, proving the affection of the constitution, and by the presence in the affected bone of special morbid elements; although the latter difference can hardly be appreciated during life, except in those rare instances where the bones are swollen. From cancer they are distinguished by the strict limitation of the morbid product to the affected bones, and by the different progress of the constitutional affection; since the patient, if he dies of the disease at all, dies of the exhaustion produced by vitiated secretion, or from the effects of mechanical interference with the viscera; not, as in extensive formation of cancer, from perverted nutrition, still less from transference of disease to remote organs.

Our knowledge of the true pathology of this complaint is as yet quite deficient, and so it follows that no means of treating it are known. The patient's strength must be supported, and he must be guarded from all exertions and shocks. If bed-ridden, his position must be accommodated to the shape of his limbs, so as to correct, if possible, the existing deformity by gradual traction, and to prevent any greater distortion. The fractures which occur in these cases are sometimes excessively numerous. Dr. Ormerod's patient had 'at one and the same time no fewer than seven fractures of different bones.' Yet in this case the fractures used to unite with the same readiness as they do in rickety bones.

Many of the cases are hardly subjects for treatment, since the disease in the bones and the distortion of the limbs has advanced to an unmanageable extent before the patient is seen; and it would be scarcely desirable, even if it were possible, to protract the course of a painless but inevitable decay.

Cancer in bone.—All forms of malignant disease are met with

in the bones, but the encephaloid, or medullary, is by far the most common.* Osteoid cancer is almost confined to the bones as a primary disease, although a very few cases are on record in which it has been found in the soft parts, without any known cancerous affection of the bones.† Cancer in bone may be either a primary disease, or secondary on cancer in some other, and usually a remote, organ. As the general considerations applicable to malignant disease have been described in the essay on CANCER, it will only be necessary here to dwell on the peculiarities which are found in cancer when developed in the bones, with reference to its seat, manner of growth, and external appearances, and to endeavour to deduce the necessary inferences as to diagnosis and treatment.

With respect to its seat, no bone is exempt from the invasion of the disease, but some bones are far more liable than others; the long bones of the lower extremity taking the lead, and the femur being of all others most commonly attacked. Out of forty cases of primary cancer, twelve occurred in the femur, eight in the bones of the leg, five in the skull, three in the pelvis, and three in the spine. The others were single cases scattered about the various regions of the body. The neighbourhood of the knee-joint is a very favourite seat of cancer; so that a soft tumour springing from the lower end of the femur or the head of the tibia is always viewed with much anxiety. Out of the above-mentioned twenty cases of cancer of the long bones of the lower limb, eleven are noted to have grown near the knee-joint.

The common kind of cancer in bone presents itself in three principal forms, viz. periosteal, interstitial, and infiltrated. The last is by far the least common. When carried to its extreme degree, the whole bone is softened by the distension of its cells with the material of soft cancer, leading to partial or complete absorption of the cancelli, and general disintegra-

* In the notes of fifty cases of malignant disease of the bones, which I happen to have by me, thirty-five are classed as encephaloid, four as osteoid, four as scirrhus, three as epithelial, one as areolar or colloid, one as melanosis of the periosteum, and the other two were tumours of doubtful nature and anomalous structure, but probably malignant. These notes, however, which are composed partly of extracts from books, partly of cases noted on account of interesting features, contain too large a percentage of rare forms of disease. This is evident in the number of cases of osteoid cancer.

† See Paget, *Surg. Path.* vol. ii. p. 496, ed. 1853.

tion of the bone. In this condition it forms one of the affections of bone which are included under the name 'mollities ossium,' under which head it has been referred to above. The periosteal form of cancer appears to be the more common in the long bones, while the interstitial is certainly the one more usually met with in the flat bones, such as the skull and pelvis, and in the joint-ends. The interstitial form is found in the shape of nodules of various, but usually small, size, scattered about the cancellous tissue. They are whitish in colour when small and recently deposited, and generally give out a creamy juice under pressure, exhibiting the various cell-forms usually met with in the juice of malignant tumours. In the harder kind of these nodules, following scirrhus cancer in the breast (and to which the designation 'scirrhus of the bones,' used by some writers, applies, while others call them 'hard encephaloid'), I have sometimes been unable to recognise any cancer-juice, or any cell-structures characteristic of cancer.* This interstitial deposit of cancer is productive of constant and wearing pain in the part, very frequently followed, in a long bone, by fracture on some slight injury or even muscular exertion. After some time, during which, if fracture has taken place, it may have consolidated, a tumour makes its appearance. The disease, having overcome the resistance of the periosteum, now grows rapidly. On dissection, a large mass of soft cancer is found, in which the periosteal envelope of the tumour may or may not be recognisable, and which springs from the bone by a narrower base, while it generally extends further in the cancellous tissue, or to a still greater extent in the medullary canal. In rarer cases, several separate nodules are found scattered about the cancellous tissue. The bone in the neighbourhood of the cancerous deposit is often thickened,† sometimes to an extent that can be appreciated by external examination.

The accidental peculiarities of shape and arrangement in the various specimens of interstitial deposit of cancer have given rise to different terms, which having now lost some of their significance, ought to be, and have very generally been, allowed to become obsolete. Thus, when such a deposit in the articular end of a bone grows into a number of cancelli in different

* This was so in a case reported in *Path. Soc. Trans.* vol. xi. p. 220.

† Paget, *Surg. Path.* vol. ii. p. 362, ed. 1853; *Path. Soc. Trans.* vol. x. p. 249.

directions, the whole of the head of the bone becomes enlarged, forming a sort of multilocular cyst, the spaces of which are filled with the tumour, and the surrounding part of the bone a good deal consolidated. Such a swelling has been called the *malignant exostosis*. In other cases the soft tumour expands the outer layer of the bone uniformly, without producing fracture, and thus a swelling is formed, the wall of which crackles under the finger. This was called a *spina ventosa*.

In the periosteal form, the tumour makes its appearance sooner and grows more rapidly than in the interstitial. The subjacent bone is generally quite unaffected, and a section of the disease shows a ring of healthy bone surrounded by a radiating mass of malignant substance. The periosteum appears in some cases to have degenerated and become converted into the structure of the tumour; in others, it may be traced over the tumour, which then seems to grow between the bone and periosteum.* In this form of the disease there is a strong tendency to ossification, so that, after maceration, a large quantity of irregular bony deposit is left on the surface of the bone, forming very often a coral-like mass, with some approach to a spiral arrangement of its laminae. These specimens were often described by the older writers as periosteal exostoses, their true nature being overlooked in consequence of the bone not having been examined till after maceration.

Cancer in bones is sometimes said to be a less rapidly fatal disease than in the soft parts, and perhaps if we compare it (as would seem most correct) with the average duration of *soft* cancer in the soft parts, this may be so; but the difference is not very marked. In twenty-eight of the cases contained in my notes the disease was followed till the patient's death from its commencement, with such approach to accuracy as is possible in these circumstances. In twelve of them death took place in less than a year (in five in less than half a year) after the first symptoms were noticed by the patient, and ten of the others died within the second year. In two only of the remaining cases was the disease protracted much beyond the usual period of duration of cancer, but neither were cases of encephaloid cancer: one, a case of colloid, might possibly be erroneously classed among malignant diseases. The true encephaloid cancer, then, in the bones, as in other parts, is more rapidly

* *Path. Soc. Trans.* vol. i. p. 320.

fatal than scirrhus, although its progress in the bone may be somewhat less rapid than elsewhere. But besides the encephaloid, all other forms may in exceptional cases be met with. Some pathologists, indeed, deny the existence of scirrhus in the bones, preferring to class the small hard nodules found in the spine, skull, and long bones, secondarily after scirrhus of the breast, and more rarely after scirrhus of other parts, as 'hard encephaloid.' The difference in nomenclature is a matter of no importance. Hard cancer, indeed, when deposited in the bones, cannot of course draw to itself the neighbouring parts and thus reduce the volume of the organ in which it is placed, so that it is destitute of that puckering so characteristic of scirrhus of the breast. But in other respects it seems identical. The small irregular lump, creaking under the knife, emitting a very scanty juice, and presenting under the microscope, besides a good deal of common fibrous tissue, only small nuclear bodies, and those perhaps in no very large proportion, bears a sufficiently close resemblance to scirrhus in other parts to deserve the same name, more especially when only another product of the selfsame disease. Epithelial cancer attacks bones usually in the course of a cancerous ulceration of the soft parts which cover them, but scattered instances of its occurrence as a primary disease are on record. Thus in the *Path. Soc. Transactions*, ix. 358, will be found a description of this disease in the base of the skull. It presented the appearance of a mass of fibroid tissue, the meshes of which were filled with a yellow opaque and thick material, which could be squeezed out in the form of commedones, and consisted of a mass of epithelial scales. But these cases are of too rare occurrence to have much of practical importance; nor in the few scattered cases of colloid disease affecting bones with which I am acquainted, is there anything to throw light on the controversy as to the malignant or non-malignant nature of that affection. Melanosis affects bones very rarely, and probably is always a secondary formation; as in the case which has furnished the figure on p. 804. The osteoid cancer has been sufficiently described elsewhere in this work (vol. i. p. 574).

In the *diagnosis* of cancer of the bones two difficulties present themselves—*first*, to distinguish between a soft tumour and an abscess or other inflammatory affection; and *second*, to distinguish between a malignant and an innocent tumour.

The diagnosis between a tumour and an abscess is sometimes very difficult. The question occurs only, as far as I have seen, in the neighbourhood of a joint; where also the doubt sometimes is, whether the swelling is not due to thickening of the synovial membrane. Generally speaking, however, the soft tumour is limited to one portion of the circumference of the bone, while disease of the synovial membrane would involve the whole circumference, although not necessarily equally prominent over the whole. Further, the chronic thickening of the synovial membrane will have been preceded by a long course of

FIG. 197.



Melanotic cancer infiltrating the cancellous interior of the shafts of the long bones. Sections of the humerus:—*a*. A section taken somewhat parallel to the axis of the bone through its cancellous portion, showing the uniform infiltration of the cells with melanotic matter. *b*. A transverse section. The cortex of the bone is seen to be quite free in this section; but at other parts a few points of melanotic deposit were met with. The preparation was taken from the body of a woman who had been operated upon for the removal of a melanotic tumour. The disease returned in various parts of the body. The whole skin resembled that of a person who had long taken nitrate of silver, and melanotic matter was found both in the rete mucosum and in the derma. There was also extensive deposit in many of the internal organs. From a preparation (Series ii. No. 234) presented to the Museum of St. George's Hospital by Mr. Campbell de Morgan.

symptoms of disease in the joint, and these symptoms will probably have been more acute at some previous time; while the tumour will have commenced much more recently, at first without any symptoms, and the symptoms will have been more marked as the tumour got larger. Limited abscesses, also, in the thickness of the swelling, are common in the chronic synovial disease, while abscess is a rare complication in the course of a tumour, and then forms external to it and singly.

The following instance of the occurrence of abscess around a rapidly growing tumour, will illustrate the difficulty of the diagnosis in such a case. A young woman was admitted into St. George's Hospital under the care of Mr. Cæsar Hawkins, complaining of pain near the ankle; no diseased appearance then existed. Soon, however, a soft swelling made its appearance, fluctuation was detected, and an incision behind the internal malleolus gave exit to pus mixed with blood, and exposed a cavity which appeared to be that of an ordinary abscess. After a few days arterial hæmorrhage came on, and soon became uncontrollable. Pulsation also became evident in the swelling. The incision was extended, and several pieces of soft, breaking-down tissue escaped; the finger passed into a mass of fungous matter springing from the os calcis. After amputation the disease was seen to be a soft tumour, about the size of a walnut, connected by a broad base to the calcaneum, and surrounding the posterior tibial vessels. The artery showed a small perforation.

It is seldom, however, that such difficulty is experienced as in this case in forming the diagnosis; and if from the ambiguity of the symptoms, and the thickness or tension of the soft parts over the swelling, doubt is felt as to the presence of a soft solid or a collection of fluid, the introduction of a grooved needle will in most cases decide the question. Usually the lobulated surface of the tumour, and the healthy and uninflamed state of its coverings, suffice to distinguish it from an abscess.

The diagnosis between malignant and innocent tumours is often very difficult, and sometimes impossible. It is of most importance, and unfortunately is also of most difficulty, in those which grow around the lower end of the femur. Malignant and myeloid tumours here often bear the strongest resemblance to each other, so that the diagnosis in an early stage of the cancerous affection can be only conjectural. By a reference to the essay on TUMOURS (vol. i. p. 536) the reader will see that the points to which the surgeon is to direct his chief attention are the length of time during which the tumour has existed without constitutional or glandular affection, the bulk to which it has attained, and the extent of its attachment to the bone, since myeloid disease is an affection of the cancellous ends, while encephaloid often surrounds the shaft to a considerable extent, forming a long oval tumour, like a great ferule. But it must be allowed that the diagnosis between these forms of disease can hardly be expected to be accurate, inasmuch as there is strong reason for believing that myeloid tumours are occasionally malignant. There are other tumours also which could hardly be distinguished from cancer until a long progress had proved their innocence. Such are the fibro-cystic, to be

afterwards mentioned, and such may also be the case sometimes with enchondroma, and with the diffused osseous tumour. It is only, however, in the very early period of osteoid cancer that its malignancy is not a prominent feature. It grows rapidly, extends far along the bone, and soon affects both the constitutional powers and the absorbent system.*

In general, malignant tumours of bone may be known by their large size and rapid growth, their soft consistence, the unequal density of different parts, the large veins which ramify over them, the extent of their attachment to the bone, the frequent presence of large sanguineous cysts, the amount of pain by which their growth is attended and often preceded, and the rapid destruction of bone which they occasion. To these local symptoms the general symptoms of the constitutional affection may be superadded.

The treatment of cancer in all parts of the body resolves itself into the question of leaving it alone, or eradicating it. The only method of extirpating malignant disease of any bone which is at all satisfactory is by excising the tumour along with the whole thickness, at any rate, of the part of bone from which it springs. To remove the tumour from the surface of a bone, in the uncertainty which must always exist whether cancer has not also affected the interior, would be highly imprudent. Nor is this sufficient; for if the disease can be clearly made out to be cancerous, the whole limb, including the entire bone which is the seat of the disease, ought to be amputated. When the tumour is situated in the leg, this is a matter requiring comparatively little deliberation; the choice only lies between amputation of the leg and of the thigh, and the difference between one stump and another is of slight moment, compared to the risk of a return of malignant disease. But if the tumour affect, as it so commonly does, the lower end of the femur, the question becomes a grave one; since amputation at the hip-joint must be performed if the disease is clearly diag-

* Two cases of osteoid cancer of the femur were in the surgical wards of St. George's Hospital about the same time. In one, although the affection was not of long standing (less than a year, I believe), the inguinal glands presented the characteristic bony hardness. In the other, the tumour, which was mixed with encephaloid, was growing rapidly, and contained a large cyst, the tension of which occasioned much pain, relieved by drawing off the fluid. Amputation at the hip was successfully performed by Mr. Tatum; but the disease recurred in the lungs, and proved fatal in about half a year.

nosed as being cancerous. If there is a reasonable doubt whether the tumour be soft cancer or myeloid, or whether it be hard cancer or diffused bony tumour, undoubtedly the wisest course is to give the patient the benefit of that doubt, and to remove the limb at the lowest level at which the incisions can be carried clear of the tumour. Even if the disease should prove to be cancer, possibly the recurring disease may be in the cicatrix, and amputation of the stump at the hip-joint may prolong life. But so many cases are on record in which what has been supposed to be malignant disease in this part (and which in all the cases was most likely myeloid) has been completely arrested by amputation of the thigh, that it is only right to try the milder operation in cases not evidently cancerous.* In the fore-arm the character of the disease is usually better marked (as far as I have seen), or in dubious cases the alternative is not of much importance; nor in the humerus is the removal of the limb at the shoulder-joint by any means so formidable as in analogous operation on the lower limb. Hence in the upper limb the rule should be the reverse of that in the femur, viz. that in cases of doubt the entire limb ought to be removed.

What is the benefit of amputation in such cases as these? This is a question very difficult to determine, if the question be limited to the expectation of life. Scattered cases are met with here and there in which a disease apparently malignant has seemed to be checked after amputation; nay, where it has recurred after amputation, and then been checked by amputation higher up;† but these are rare exceptions. The disease may be expected to recur, and to prove fatal; and the operation must be defended rather on the grounds of humanity than of scientific indications, as affording relief from present suffering, and the chance of an interval of some months, perhaps even longer, of health, rather than as holding out much prospect of a radical cure of the complaint.

Pulsatile malignant tumour of bone and osteo-aneurism.—A remarkable feature in malignant tumours of bone is the occasional occurrence of pulsation in them. This pulsation can sometimes be with difficulty distinguished from that of ordinary or sacculated aneurism. The resemblance also which these malig-

* See Mr. Gray's paper in *Med.-Chir. Trans.* vol. xxxix. p. 121.

† *Path. Soc. Trans.* vol. vi. p. 291.

nant tumours of bone sometimes bear to the aneurisms by anastomosis is so strong that they have been described as 'aneurisms of bone,'* and have been believed to consist merely of a dilated vessel or vessels in the interior of an otherwise healthy bone. But it is now admitted that the great majority, at any rate, of these so-called 'osteo-aneurisms' were really pulsatile malignant tumours. The resemblance to aneurism by anastomosis is in the highest degree perplexing when the pulsatile tumour occupies a situation where that disease is common, such as the scalp.

A woman applied at St. George's Hospital some years ago on account of a pulsating tumour on the vertex of the head. Mr. Prescott Hewett, under whose care she was placed, came to the conclusion that the disease was a malignant tumour of the skull, and dissuaded her from any operation. Being anxious, however, to have the tumour removed, she consulted another surgeon, who gave it as his opinion that the tumour was an aneurism by anastomosis, and might be extirpated. Mr. Prescott Hewett accordingly sought the advice of his colleagues, and after a careful examination they confirmed him in his original opinion, that the tumour was malignant, and had perforated the cranium. He therefore declined to operate; and the woman was placed in another hospital, by the advice of the gentleman whom she had subsequently consulted, and who then attempted to excise the supposed vascular tumour. The original diagnosis, however, turned out to be correct, and it became necessary to give up the operation. Such cases as these show the difficulties which may be experienced in diagnosing the nature of such a tumour in the scalp; but it more frequently occurs that the pulsatile tumour of bone is situated on the course of some large artery,† and simulates an ordinary aneurism (see article ANEURISM, p. 453).

The anatomy of these tumours is as follows: they spring from the cancellous interior of the bone, expanding and eroding its external shell, until they burst out, frequently on both sides of the bone at once, forming lobulated masses, which sometimes attain a large size. On section they are seen to be red, of a fleshy consistence, and containing large spaces or cells filled with blood, from the pulsation of which the tumour derives its movements, and which must therefore communicate freely with the main arteries around, though the exact nature of that com-

* See especially a paper by Breschet, '*Observations et Réflexions sur des Tumeurs sanguines d'un caractère équivoque, qui paraissent être des anévrismes des artères des os.*'

† Such tumours may, however, form in any bone with copious diploë. In the *Edinb. Med. and Surg. Journ.* Nov. 1860, p. 452, is an account of one which implicated the basilar process of the occipital bone and the first three cervical vertebræ.

munication has not yet been demonstrated. The pulsation appears to depend on the resistance of the periosteum, which is often thickened. Hence when the periosteum is penetrated, the pulsation frequently disappears; as that of an aneurism will do when the sac has given way. The microscopical characters of soft cancer can be recognised in the structure forming the walls of the cells. Spicula of bone are often found mixed up with the malignant matter. The tumour frequently affects the large veins in the neighbourhood, projecting into them, or even blocking them up; and several such tumours may exist together, or malignant disease of the ordinary encephaloid variety may be found in some other organ of the body (see the case quoted on p. 455).

The diagnosis of a pulsatile malignant tumour of bone is very easy in some cases, almost impossible in others. It is easy when the tumour springs from a superficial bone, lies away from the course of any large artery, and has no bruit; and still more so when other malignant tumours or symptoms of malignant disease are present; but where its connection with the bone is obscure by reason of the depth at which its base lies, when a large artery (which is generally the iliac, gluteal, or femoral) lies near its situation, when its pulsation is accompanied by bruit,* when the tumour is solitary and the general health unaffected,—it becomes a matter of the utmost difficulty. Enough, however, has been said on this subject in the essay above referred to.

In cases where other tumours exist, or where the symptoms of constitutional cancer are present, no doubt can be felt as to the inefficacy of local treatment; the disease declares its malignancy by the same signs as cancer in other parts of the body, and its prognosis and treatment must be the same. But are there any pulsatile tumours of bone of a different kind, in which the surgeon can hold out a hope that the excision of the tumour, or its consolidation by chemical agents, or by ligature of the artery which leads to it, will offer a reasonable hope of

* Cruveilhier (*Anatomie pathologique*, 1856, vol. ii. p. 901) relates a very interesting case in which an encephaloid pulsatile tumour, springing from the bones of the skull, presented so marked a thrill, and a sound so exactly resembling that of arterio-venous aneurism, that he was led into the belief that such was the nature of the tumour, until dissection revealed its true character.

cure; or must the patient be sentenced to the hard alternative of death or amputation?

In the former edition of this work, I expressed a strong doubt of the existence of the disease ordinarily described as 'osteo-aneurism,' and gave my reasons for pronouncing all the cases which had been published up to that time, insufficient to establish its reality.* A more satisfactory example has been published by Dr. Mapother in the *Dublin Med. Press*, February 4, 1863, p. 105. In this case there was a pulsating tumour of small size situated on the tibia, accompanied by a distinct thrill and slight bruit; but without any indication of disease in other parts of the osseous system or in the body generally. The diseased tissue was destroyed by two applications of the actual cautery, in doing which its vascular nature was clearly testified by the acute hæmorrhage. No other morbid tissue was exposed by the opening which was made into the tumour; but there was, of course, no opportunity for anatomical examination. The wound healed perfectly, and I am told by Dr. Mapother that the patient remained in good health two and a half years afterwards.

Again, in the *Path. Trans.* vol. xix. 349, is the account by Mr. Bickersteth of a case where he amputated the leg on account of a pulsating tumour of the tibia, which 'felt firm, but was slightly compressible, yielding to deep pressure, and giving a spongy feel to the finger, with an occasional sensation of crackling. The skin was free and sound. No bruit was audible.' An incision was made into the tumour, which exposed a surface having all the appearance of malignant disease, and the leg was amputated under the idea that the tumour was cancerous. On examination of the tibia in front, it was found much expanded at its lower end, where a mere shell of bone remained, bending and crackling under the finger. Behind was a large oval tumour, five inches long by three broad, springing from the posterior and outer side of the expanded tibia, and running upwards from the lower end of that bone into the inter-osseous space, overlapping the fibula, but not connected with it. It had a distinct wall, and was divided into two parts by the tendons of the tibialis posticus and flexor longus digitorum, which ran in a groove or channel in the tumour, through nearly its whole length. The bulk of the tumour was found to consist of innumerable trabecular spaces; the fibrous bands composing which, as well as the walls of the tumour, were derived from the periosteum of the tibia. These spaces were filled with clotted blood. The part of the tumour external to the tibia, was formed by two large sacs, filled with clotted blood. All parts of the tumour communicated with each other.† There was no admixture of cancerous matter: and the case appeared, both to Mr. Bickersteth and to the committee of the Pathological Society who examined it, to be a perfect example of aneurismal dilatation of the vascular spaces of the bone.

Mr. Bickersteth has had the kindness to inform me that he has seen the patient very lately, and that he remains perfectly well.

* Such are Cruveilhier's case, *Anat. Path.* 1856, vol. ii. p. 901; Lallemand's, prefixed to Breschet's paper above quoted; Dupuytren's, in *Leçons orales*, vol. iii. p. 232; and I may add Capelletti's, as quoted in the *Biennial Retrospect of the New Syd. Soc.* for 1865-6, p. 249.

† The preparation is preserved in the Museum of the Liverpool School of Medicine.

We may therefore allow that in some rare cases, pulsation has been noticed in innocent tumours situated on the long bones, and displaying no other recognisable structure except enlarged vessels. It seems also that pulsation has been recognised in a myeloid tumour;* and, as these tumours are usually innocent, it would follow that the mere presence of pulsation in a soft tumour of bone is not to be considered as a decisive proof of its malignancy. If, however, we allow these exceptions to the rule that pulsating tumours of bone are malignant, we must still admit that there is no reliable account of any such tumour connected with the skull or pelvis (those favourite seats of the disease) which was otherwise than cancerous.

If such are our views with respect to the nature of the pulsatile tumour of bone, our opinions as to the proper course of treatment cannot be doubtful. To tie a large artery is so very grave a measure, that it can only be justified by the clear prospect of impending fatal hæmorrhage, or by the presence of an aneurismal tumour pressing upon important organs. In these pulsatile tumours, however, hæmorrhage is rare, and only occurs late in the disease; nor are important parts often pressed upon, except in the cranium. If it be said that the growth of the tumour will be checked by the ligature of its nutrient vessel, the answer is, that this is by no means borne out by experience, and that even if its growth were checked, the disease would not therefore be cured; while the doubtful good to be derived from a very uncertain diminution in the bulk of the tumour is as nothing when compared to the frightful risk of tying a large artery in a subject probably already debilitated by the cancerous cachexia. In many of the recorded cases, the ligature of the main artery appears so far to have affected the tumour as to have checked its pulsation. But the pulsation, though a formidable symptom, is not an essential, and may not even be a constant, part of the disease. Thus Professor Miller relates† a case of pulsatile malignant tumour in the ham, which was at first mistaken for aneurism. The pulsation disappeared spontaneously, but returned after an exploratory puncture made in the tumour. Afterwards the

* Gray, 'On Myeloid Tumours of Bone,' *Med.-Chir. Trans.* vol. xxxix. p. 138.

† *Edinb. and Med. Surg. Journal*, April 1860, p. 963.

pulsation varied, disappearing occasionally, and then recurring.

The purport, then, of all that has been noted as to the course and nature of this disease, and as to the effect of treatment, appears to justify the following conclusions: that in pulsatile tumours connected with the bones of the extremities, if the tumour be small and the other symptoms favourable, the surgeon is justified in treating the disease as an instance of the rare occurrence of osteo-aneurism, and endeavouring to extirpate it either by cutting away the portion of bone from which it springs, or (better) by caustics or the actual cautery; that if it be of large size, amputation should be recommended through or above the nearest joint, except in those connected with the lower end of the femur, where it may occasionally be advisable to amputate near the tumour; that the ligature of the main artery of the limb is unjustifiable; that in pulsatile tumours connected with the head, chest, or pelvis, no local measures ought, as a general rule, to be employed, but the disease should be treated as one of cancer; and finally, that the prognosis may be rendered somewhat less grave by remembering that pulsation has been noted in a myeloid tumour.

Cancerous ulceration is usually preceded by a known and evident tumour, probably epithelial; but in some cases the malignant deposit may have been entirely interstitial, and in others the patient is not seen until extensive ulceration has destroyed any tumour that might have existed. Such cases occur most usually about the bones of the face; and I have seen death produced where the lower jaw was implicated in a case of this kind, by the extension of the ulceration into the lingual artery. During life some difficulty may be experienced in distinguishing this cancerous affection from the rodent or phagedænic ulceration, spoken of at p. 759; but it is a matter of little practical importance, since amputation or complete excision would be recommended in either case, if the patient's general condition admitted of it. The bones of the face are peculiarly liable to extensive destruction in canceroid ulceration and in lupus, but the chronic course of these affections sufficiently distinguishes them from cancer.

In the macerated bone, malignant ulceration produces extensive and irregular destruction both of the compact and cancellous tissue, without any trace of the periosteal and other

inflammatory deposit that bounds the more healthy forms of ulceration (see Fig. 198).

NON-MALIGNANT TUMOURS.

Tumours of bone are like those of soft parts in all important respects. They are innocent or malignant; the former being, for the most part, composed of some of the same structures as form the bone itself, in a more or less perfect state of development (homologous tumours); while the malignant tumours are composed of other structures, to which the osseous tissue in a state of health presents no analogues (heterologous). The parts which compose a bone are fibrous membranes, cartilage, the proper osseous tissue or granular base, and blood-vessels; together with the spaces or cancelli filled with fat, which give the bone the requisite lightness. Now any of these elements over-developed or imperfectly imitated may give rise to a tumour. The overgrowth of the fibrous tissue gives rise to the true fibrous tumour; its imperfect imitation by morbid action produces the various forms of fibroid or fibro-plastic tumour; excessive or misplaced growth of cartilage results in enchondroma; of bone in exostosis. Whether the vessels of bone are ever simply over-developed, without any other morbid product, so as to form the 'osteo-aneurism' spoken of by numerous surgical pathologists, is a question which has been discussed above. From the over-distension of the cellular spaces of bones, some of their cystic tumours probably arise; others are formed by a peculiar arrangement of the connective tissue in tumours belonging to different classes; and some of the growths, which are classified with cysts, are merely entozoa in the cancellous tissue. Lastly, analogous to the fat and medullary tissue which fills the cavities

FIG. 198.



Malignant ulceration of bone. (Museum of the Royal College of Surgeons. No. 640).

of the bones, we have a class of tumours, the myeloid, which, since their first description by Mr. Paget, have not ceased to attract much attention, on account of the interesting surgical and pathological questions connected with them.

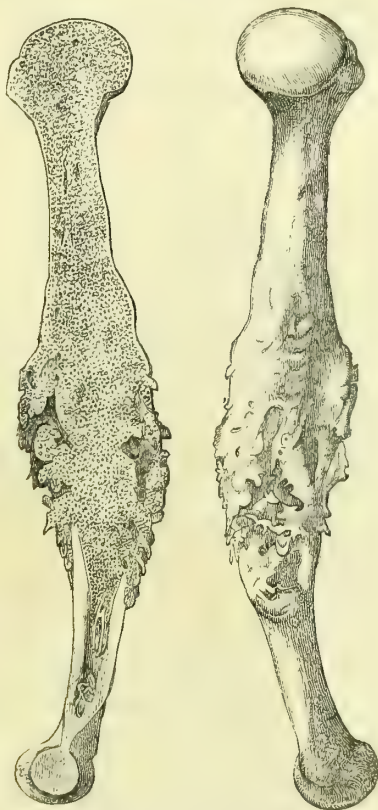
Enchondroma.—Cartilaginous and bony tumours can hardly be treated of separately, for although the well-marked specimens of either class present little similarity at first sight, some of each are so intimately related, that the two could not without confusion be made the subjects of separate sections.

Cartilaginous tumours, or enchondromata, as they are called, have been already described in the essay on TUMOURS (vol. i. p. 530), so that it now only remains to speak of them as they affect the bones.

These formations may be divided, for surgical purposes, into two classes: the circumscribed and the diffused. The former as a rule do, and the latter do not, show a tendency to ossify throughout their whole extent; although even in the diffused enchondromata the part of the bone from which they spring is often occupied by a considerable osseous deposit, while the bulk of the tumour remains unossified. The diffused enchondromata usually grow as extensive infiltrations into the tissue of the bone and periosteum, and in the course of time spread slowly over the surface of the bone (retaining for the most part their covering of periosteum), and fill all the spaces or cavities in relation with the bone. Such was the case in the instance shown in Fig. 199, where the whole medullary canal of the shaft of the humerus is occupied for a considerable extent by porous bone forming the base of a cartilaginous tumour, which surrounded the bone, and had been growing for a long period without much inconvenience to the patient. It is difficult to determine their precise origin, and thus to make sure whether they are new formations, in a strict sense, or out-growths; but the former opinion seems more generally probable. I have, however, met with one of these tumours, in the phalanx of the finger of a child, where it seemed probable that the origin of the tumour was the epiphysial cartilage. These non-ossifying cartilaginous tumours, or pure enchondromata, are little amenable to surgical treatment, unless in a part favourable for amputation. They have been supposed to present some analogy to malignant diseases, to which, indeed, their

extensive diffusion and steady irresistible progress do offer a resemblance. They differ, however, from the true cancers at any rate in one feature, which is quite characteristic, viz. that however extensive their diffusion, they affect the surrounding parts only by pressure or absorption, not by contamination. This is their most distinctive feature; but it is not so useful in diagnosis (since it is less easily appreciated during life) as their rate of growth, which is usually slow. To this rule there are,

FIG. 199.



The humerus in a case of diffused cartilaginous tumour. (Museum of St. George's Hospital. Series ii. No. 183.)

however, rather frequent exceptions, of which three remarkable instances are related by Mr. Paget,* in one of which the rapid growth of the tumour led to the erroneous diagnosis of malignancy, and so deprived the patient of the chance of recovery

* *Lectures on Surg. Path.* vol. ii. p. 181.

which amputation would have given him. Remembering these and similar cases, we must not be too confident in inferring malignancy in the case of a tumour of bone from the single fact of rapidity of growth, although that is, doubtless, a most suspicious and unfavourable symptom. In many cases, these large cartilaginous tumours remain stationary for a long period; and this should be taken into consideration when consulting on the propriety of amputation.

The structure of these tumours varies; usually they are quite solid; in other cases cysts, filled with fluid, are found in them, as in the beautiful specimen from which the annexed

FIG. 200.



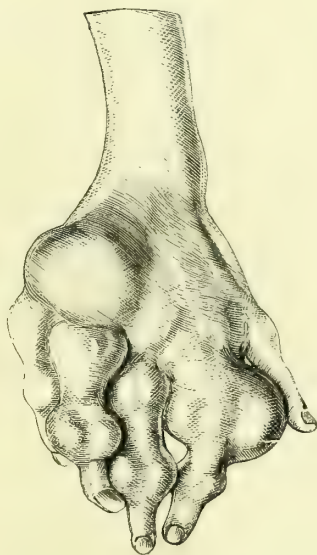
Cystic enchondroma. (Museum of the Royal College of Surgeons. No. 203A.)

figure was taken. They sometimes consist exclusively of cartilage; but more commonly fibrous tissue is to be found, in sparing quantity, in some parts of them. The microscopical appearances will be found described in the essay above referred to.

The circumscribed cartilaginous tumours are, however, much more frequently met with, and are, therefore, more important in practical surgery. They spring almost exclusively from the long bones, the phalanges of the fingers and toes being their

most frequent seat. A small enchondroma is comparatively often met with, springing from the end of the last phalanx of the great toe, raising the nail up, and giving a good deal of pain in wearing the boot. It should be cut away from the bone, and usually will not return; should it do so the phalanx must be removed. In the hand and foot, enchondromata are often found in great numbers at the same time; and the appearance thus presented is very characteristic, and is not, as far as I know, imitated by tumours of any other kind. The fingers are studded over with bosses or knobs, looking something like the dry gnarled branches of an old tree. Of this

FIG. 201.



Model of a hand affected with numerous enchondromata. (From the Museum of St. George's Hospital.)

form of disease the annexed is a good illustration. This affection is seen generally about the age of puberty. It is, of course, quite incurable, except by amputation; but that measure should never be resorted to in any disease of the hand without evident necessity. In the foot less scruple need be entertained, since the foot, deprived of its anterior portion, is still a very useful member; and there would be no necessity, even in a very advanced case, for going further than Lisfranc's or Chopart's operation. I have never seen a case where anything

more was required than to remove one or two toes. In the hands, these multiple enchondromata, if left alone, grow generally very slowly, and sometimes not at all. Cases are, however, on record where they seem to have increased slowly during the whole period of life, and to have attained at length a truly extraordinary development. Of this the specimen figured by Müller* is an excellent instance; and a very similar case has been described and figured by the writer,† where, however, the cartilaginous structure was less distinct. Such tumours usually originate in the interior of a bone, expanding its walls into a thin bony cyst or shell, which is liable to give way at different parts, and firm pressure will then elicit a feeling of crepitation (see Fig. 202, on p. 821). These multiple enchondromata, like the diffused cartilaginous tumours just described, seem to show little tendency to ossify in the strict sense of the term; but they undergo, when very old, a process of calcareous degeneration, which, added to their general increase in size, produces ulceration of the skin over them; and so a condition is brought about not unlike that of a mass of enormous chalkstones exposed. More rarely the tumours spring from the surface of the bones.‡

Circumscribed and solitary enchondromata usually grow from the surface of a bone, and most of them show a strong tendency to ossify, the process commencing generally at the base. Hence the surgical considerations applicable to them are identical

* *Ueber den feinern Bau und die Formen der krankhaften Geschwülste*. Berlin, 1838, tab. iv. fig. 1.

† *Path. Soc. Trans.* vol. ix. p. 382. The specimen is in the Museum of St. George's Hospital.

‡ With regard to the ordinary seat of cartilaginous tumours of bone, Dr. Pirrie makes the following observations, which I believe to be generally true: 'I have now seen in my own experience nine specimens of cartilaginous tumours near the ends of long bones, and they have all been situated between the walls of the bone and the periosteum, and in no instance extended to the cartilage of incrustation at the end of the bone. I have met with fifteen examples in metacarpal bones, and they all originated within the bone, and caused more or less of expansion of the walls and their conversion into a thin crust or shell around the tumour, in various instances at parts completely absorbed. I have seen and carefully examined seven examples of the same kind of growth in the middle of the long bones, and they were all placed within the canal and around the wall of the bone. Judging from my own comparatively limited experience I would conclude that the favourite site of the first class is around the bone; of the second within it; and of the third, both within and around it.—*On Acupressure*, p. 107.

with those which apply to exostosis. When a circumscribed enchondroma grows in the interior of a bone, as in the figure above referred to, it can be readily enucleated, and when a small cartilaginous tumour springs (as it often does) from the end of the last phalanx, usually of the great toe, its removal is very easy, and is always, as far as I have seen, permanently successful.

Diagnosis.—The diagnosis of innocent tumours from each other is uncertain and obscure in all parts of the body, and perhaps more so when they are connected with the bones, on account of the generally deep position of the latter. If, however, a tumour presenting the general characters of innocency can be clearly made out to be springing from bone, the chances are very great in favour of its being an enchondroma or an exostosis. If very large, it can hardly be the latter without displaying characteristic hardness. Fibrous and fibroid tumours may be found of large size; still almost all large non-malignant tumours of bone are cartilaginous. Most, also, of the smaller tumours, which do not possess the hardness of exostosis, will be found to be cartilaginous. Such tumours usually possess a certain amount of resilience, and often appear obscurely movable on the bone. This sensation, however, is often deceptive, and due, apparently, to the motion of the soft parts upon the tumour; it has been noticed in tumours, the base of which has been found to be completely ossified, and a slight amount of apparent movement is therefore no conclusive reason for denying the connection of a tumour with the bone. Another thing which ought to be taken into account in diagnosis is, that the cartilaginous, equally with the osseous, tumours may have a bursa over them. This will not often be an obstacle in the way of making out an exostosis, since the hardness of the latter is transmitted through the fluid, but may sometimes cause doubt about the nature of an enchondroma. The nodulated surface of enchondroma, though characteristic to a certain extent, is far from distinctive of the disease; the same property may belong to colloid disease, fibrous tumour, and other swellings; in fact, the only sensation which affords a reasonable ground for pronouncing a tumour cartilaginous is resilience combined with solidity; and this for deep-seated tumours is often deceptive, and in the many enchondromata enclosed in shells of bone is, of course, absent. On the whole, therefore, an enchondroma is best known by its being

an innocent, and not osseous, tumour; elastic when firmly pressed, generally growing slowly, and not affecting the skin. When the phalanges are the seat of the disease, the diagnosis is much more nearly certain.

Exostosis.—The transition from cartilaginous to bony tumours is a natural one, since so many of the former are merely the first stage of growth of the latter. The term ‘exostosis’ is not a very easy one to define. It ought to be used only to signify an innocent tumour, or limited out-growth, formed exclusively of bone, and not the result of inflammatory action; but, on the one hand, the products of inflammation secreted by the periosteum often assume the form of a limited out-growth or tumour; while, on the other, many complex malignant tumours possess a bony framework, and, after maceration, bear a great resemblance to exostosis. In the latter case the distinction, though occasionally difficult after the bone has been macerated, is easy during life; so that the mere fact that a malignant tumour possesses a more or less perfect bony framework is of little moment in a practical point of view. Most of the growths which fall under the category of ‘periosteal exostosis’* are extensive inflammatory deposits beneath the periosteum, which neither require nor admit of surgical treatment. Whether limited, pedunculated, and therefore removable, tumours ever occur as a consequence of inflammation is as yet doubtful; but it is highly probable that they do, both from the analogy of the elongated processes sometimes found projecting from the bone in the neighbourhood of fractures which have been consolidated with more than the usual amount of inflammation,† and also from the following considerations. Exostoses are occasionally found attached to the bone only by a neck composed of fibrous tissue. The occurrence of masses of new bone around the articular ends in the inflammatory disease known as ‘chronic rheumatic arthritis,’ and the probability that such masses become subsequently blended with the original bone, is now a familiar fact in pathology.‡ Specimens have been exhibited in which it seemed that inflammatory appearances could be

* See Gerdy, *Maladies des Organes du Mouvement*, p. 272; Fano's edition of Vidal de Cassis, *Pathologie externe*, vol. ii. p. 261.

† See a preparation in St. George's Hospital Museum, series i. No. 166.

‡ On this head I would especially refer to a paper by Mr. W. Adams, in *Path. Soc. Trans.* vol. iii. p. 156.

traced around some of the loose exostoses previously referred to; * so that it is possible that some exostoses may be developed, as the masses of bone are which form so striking a feature of chronic rheumatic arthritis, in the soft structures near the bone, as a result of inflammation, and may afterwards coalesce with the original bone. The great majority, however, of those bony tumours which are called, in surgical language, exostoses, originate by an out-growth or limited hypertrophy of analogous parts, just as fatty, fibrous, and other innocent tumours do, quite independent of any inflammatory symptoms. Many authors, especially the French surgeons, speak of 'bullous exostoses,' meaning apparently by this term those shells of bone which sometimes are formed by the development of a tumour (generally cartilaginous) in the centre of the shaft. Such a case was the one from which the accompanying figure is taken. Another kind of exostosis is that which proceeds from the ossification of tendons, or from the occurrence in man of processes of bone natural to the lower animals. Both of these belong rather to the class of museum curiosities than of subjects of practical interest. Still, if they became objects of treatment, they would probably be indistinguishable from exostoses, and would require the same operation. Few museums are without a specimen of ossification of tendons and other fibrous tissues. Some cases of this kind will be found referred to on p. 636, where also the treatment of persons presenting this tendency is discussed. Such cases as those in which a process projects from the humerus around the brachial artery, when that vessel follows the course usual in the large feline animals, in which it is surrounded by a ring of bone, only need to be known in order to avoid operative interference; and in any operations on bony tumours in regions where such anomalies are known to exist, the nature and history of the case ought to be first carefully investigated.

Excluding these rarer varieties, the cases of circumscribed

FIG. 202.



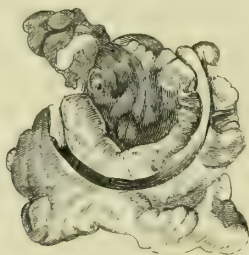
Bullous exostosis on the phalanx of a finger; probably a shell of bone expanded around a cartilaginous tumour. (From a preparation in St. George's Hospital, Series ii. No. 151.)

* Gay, in *Path. Soc. Trans.* vol. iv. p. 244.

exostosis which surgeons have to treat are divided into two classes—the cancellous, and the ivory; the former being a reproduction of the tissue of the interior, as the latter is of the hard exterior of the bone. They will be found fully described in the essay on TUMOURS (vol. i. p. 536).

Treatment.—The slow rate at which exostoses progress, and the ease with which the soft parts accommodate themselves to the gradual advance of the tumour, render it frequently unnecessary to meddle with them; and it is always right to defer the operation until it is clearly seen to be necessary; since there is always great risk in operating on any deep-seated tumour, and still greater in laying open the cancelli of bone, as must be done in dividing the neck of an exostosis. Diffuse suppuration in the intermuscular spaces, erysipelas, and pyæmia are very liable to follow such operations. When the exostosis

FIG. 203.



Ivory exostosis which was trephined unsuccessfully, on account of its great hardness. Exfoliation was afterwards produced by the long-continued application of caustics chiefly nitric acid. (From the Museum of St. George's Hospital, Series ii. No. 189.)

is of the ivory variety, and situated on the cranium, the operation is much more dangerous. Here, indeed, it not unfrequently happens that the tumour is so hard as to resist all the tools which can be brought to bear upon it, so that it is physically impossible to remove it.

A striking example of this occurred in a case which has furnished a preparation to the Museum of St. George's Hospital. A man, suffering from a small ivory exostosis in the frontal region, fell under the care of the late Mr. Keate, one of the boldest and most skilful operators of his day, who perseveringly, but vainly, endeavoured, by the use of trephine, saw, chisel, and mallet, during the space of nearly two hours, to cut off the little lump of hard bone. The patient was fortunate enough to recover from this proceeding; and Mr. Keate, convinced of the uselessness of further operation, determined to attempt the extirpation of the tumour by the free application of potassa fusa

and nitric acid to its exposed base. This was successful. The caustics, in the course of years, ate their way through the base of the tumour, which dropped off. The tumour figured in the accompanying illustration (Fig. 203) still shows the deep groove worked into it by the trephine at the time of the operation.

It would be rash to say that such operations are unjustifiable, since exostosis in the neighbourhood of the orbit may grow into that cavity, or into the cranium, and cause death, or some horrible deformity almost worst than death, by displacement of the eyes, or bones of the face ;* but the risks of operating on these small exostoses about the cranium should be maturely weighed. Some tumours, however, which present on the surface the character of the true ivory exostosis, may turn out on section to be hard only on the exterior, and to consist of a soft diploic tissue internally. This is the case usually, if not solely, when the bone from which the tumour springs resembles the composition of the vault of the skull, that is to say, consists of diploë covered by a thin table of compact tissue. In bones of which the shell is more dense, such as the lower jaw, it is much more probable that the whole thickness of the tumour will be of compact structure. The exostoses which consist of diploë internally covered by a thin shell of hard substance (and which I venture to think more common than they are usually said to be), are, of course, much more easily removed than the true ivory exostoses which they simulate ; and another circumstance which renders the prospect of operations on large exostoses, whether on the skull or other parts, rather more promising than would appear at first sight, is that the tumour when exposed is sometimes found to be connected to the surface of the bone by a very narrow neck, from which it can be easily broken or cut off.† It is, however, only rarely that either the surgeon, or the patient, will make up his mind to the dangerous and doubtful experiment of an operation on an ivory exostosis, especially of the cranium ; whereas operations on the more common forms of exostoses which spring from the shafts of the long bones, and present the cancellous,

* Some remarkable specimens are in the Museums of St. Bartholomew's Hospital and of the College of Surgeons. Exostoses of the orbit are not always of this dense quality. See a case in *Path. Soc. Trans.* vol. xi. p. 264, where the tumour was soft, and easily removed.

† A most interesting case of a tumour of this kind, growing from the cranium, is reported in the *Path. Soc. Trans.* for 1850, p. 149, with a drawing, and has been commented on by Mr. Prescott Hewett in his Lectures on Diseases of the Head.

or mixed cartilaginous structure, are of daily occurrence. Their most common situation, after the phalanges, is near the knee, springing from the inner surface of the femur, a little above the condyle. Another very common situation is beneath the deltoid muscle.

The removal of such an exostosis is, in most cases, easy, since the base is not generally very broad, nor the ossification very compact. Some are even so soft as to be divisible with a strong scalpel. A few again are not united to the shaft by bony matter, but by ligamentous union.* This condition is highly favourable for operation, not merely because the tumour can be more easily excised, but also because the vascular spaces of the bone will not be laid open in the operation.

In other cases the tumour is broader, and more firmly ossified, at its base than in any other part; and these are the least favourable cases for operation, since the division of so large a mass of bone requires great and prolonged violence, peculiarly likely to be followed by the complications above enumerated. But the operation is necessary when the tumour is growing, and is threatening the functions of important parts; and in such cases the operator must be prepared for the difficulties which he may have to encounter, and should have a sufficient supply of instruments of adequate strength at hand, such as stout bone-nippers, a chain-saw, other saws of various shapes, chisels, and mallet. In all cases the base of the tumour should be clearly exposed, and separated with care from the parts around, which may require to be held back with retractors. The separation should be commenced from the side where any danger is to be apprehended (*e.g.* in consequence of the proximity of a vessel or joint), in order to avoid implicating any important part; and then any amount of force necessary must be carefully but firmly applied, the bone being steadied by assistants.†

* The observations made on pp. 820, 821, and the case of Mr. Gay's patient there referred to, will render it probable that exostoses are sometimes formed in the soft parts around the bone. These, of course, are connected to the bone, at least originally, by ligamentous tissue. Again, ossification of an enchondroma may proceed from without inwards, instead of its more usual course from within outwards. In a third class of cases, exostoses may be movable on the bone as the result of fracture. See a preparation in the Museum of St. Bartholomew's Hospital, series A, No. 183.

† It may not, perhaps, be out of place to remark, that in case of an exostosis situated near the knee-joint, there is the more danger of opening the

The 'bullous exostosis,' or central enchondroma contained in a bony cyst, usually requires amputation of the phalanx upon which it is seated.* It may, indeed, be sometimes possible to enucleate the growth, and I have seen this done with success; but as a general rule it is hardly worth while to attempt it; since, if the disease be seated in the hand, the necessary disturbance of the tendons would probably render the finger useless; and if in the foot, the certainty of a speedy and complete recovery would outweigh the advantage of preserving a portion of one of the toes.

Diffused bony, or innocent osteoid, tumour.—Besides these forms of limited exostoses, a diffused bony tumour is occasionally met with, in which the whole thickness of the bone for some distance is converted into a lobulated mass of spongy bone, which, in a section of such a tumour that I had the opportunity of examining microscopically, presented the usual structure of bone, but with smaller cavities, and an increased deposit of the granular base.

The specimen (in the Museum of St. George's Hospital, series ii. No. 185) is larger than a man's fist, and involves one side of the lower jaw, from the condyle to near the symphysis. Its innocent nature is clearly proved by the fact that it had been growing for five years without any detriment to the general health, and had been partially removed on a previous occasion without any ill consequences from cutting into the interior of the tumour. On the patient coming under the care of Mr. Tatum, the tumour was completely excised, and with success, as the man was seen in perfect health several years afterwards.†

Another still more remarkable case is illustrated by a series of three preparations in the Museum of the College of Surgeons. The history is so interesting that a condensed report of it must be introduced. The thigh was originally amputated on account of a hard and heavy dry osseous substance, surrounding the ends of the femur and tibia, projecting into the knee-joint, extending far up the thigh, and implicating the popliteal artery, vein, and nerve, so as to cause oedema and severe pain (Prep. No. 3244) shown in the accompanying figure. The patient remained well for five years; then another osteoid tumour formed on the stump of the femur, accompanied with severe pain. Amputation was performed higher up. The tumour appeared to grow,

joint, since the presence of the tumour has probably caused numerous attacks of synovitis, which have left the pouch of synovial membrane extending up the thigh permanently enlarged.

* I have never seen a tumour of this sort connected with the larger bones; but the statement in the text would apply still more forcibly to such a tumour.

† *Path. Soc. Trans.* 1848-9, p. 95.

not from the bone itself so much as from the periosteum, and enclosed the femoral artery (Prep. No. 3245). There was again an interval of health for two years; then a fresh tumour formed about the stump, continued to increase upwards, out of reach of operation, and finally killed him, from inflammation and sloughing of its soft coverings, *twenty-five years* after the first appearance of the disease. He had been in good general health during the whole time (Prep. No. 3245, A).*

FIG. 204.



Diffused bony tumour of the femur and tibia: the popliteal vessels and nerve are seen surrounded by the bony growth, the veins varicose from the pressure. The tumour overlaps the fibula, which, however, is not affected. (Museum of the Royal College of Surgeons. No. 3244.)

This history presents a remarkable analogy to that of the recurrent fibroid, or fibro-plastic, tumours of soft parts. There are the same leading features, viz. the local malignity of the disease combined with innocence constitutionally, its imperfect imitation of the tissues in which it grows, its constant recurrence near the site of an operation, and, finally, the mode of

* Another, and very similar, case may be found in Mr. Paget's *Lectures on Surgical Pathology*, vol. ii. p. 506.

death—from exhaustion and sloughing after repeated operations, not from infection of the system.

Cysts in bone are of two kinds; viz. serous and sanguineous. The serous, or mucous, cysts which occur in the jaws as a consequence of irregularity of the growth, or position, of the teeth will be found treated of in a subsequent essay. In such cases the formation of a cyst containing clear fluid is susceptible of an intelligible explanation; but it is difficult to see how simple serous cysts can be developed in other bones, and probably the few cases which are to be found in books rest upon erroneous diagnosis.* But cavities containing clear fluid are formed in bones by the growth of hydatids in their interior; and if simple cysts do occur, they would be indistinguishable from hydatid cysts before operation, and would require the same treatment.

Blood-cysts are not of common occurrence, nor is it usually easy to determine their pathological nature. Many of the cases reported under this title appear to have been examples of malignant tumour, in which a cyst has been developed, much exceeding in relative size the solid portion of the growth.†

The most distinct description of a blood-cyst in bone to which I can refer is by Travers, in the *Med.-Chir. Trans.* vol. xxi. He excised the greater part of the clavicle, on account of a large cystic tumour of about a year's growth, which was very clearly connected with a history of injury. The tumour consisted of an arrangement of cells or chambers, of pretty equal dimensions, filled with dark solid coagula of blood, with spicula of bone in their walls, and invested by a very stout fibrous membrane. 'The investing membrane was evidently the condensed periosteum, the cells were the irregularly-expanded cancelli, and the calcareous particles were the debris of the bony plates and walls.' Travers is inclined to attribute the disease to expansion of the bony cancelli from blood effused into them as the result of violence. If this explanation be accepted, the affection would be identical with the blood-tumour, or hæmatoma, which is occasionally found in the soft parts as the result of contusion (see vol. i. p. 622). Mr. Stanley also relates a case‡ in which he amputated the thigh successfully on account of a blood-cyst originating in the condyles of the femur, and where both the femur and the tibia presented 'an ecchymosed condition from minute effusions of blood through their compact tissue.' This condition existed in the femur up to, if not above, the level of the amputation; yet the disease had not recurred six years afterwards. Mr.

* Mr. Stanley (op. cit. p. 194) denies the formation of simple cysts in any other bones than those of the jaw.

† See a case reported by Mr. Liston, under the name of 'ossified aneurism of the subscapular artery,' *Ed. Med. and Surg. Journ.* vol. xvi. pp. 66, 215.

‡ Op. cit. p. 187.

Stanley, however, in his description of this tumour, is careful to mention the fact that there were distinct portions of solid matter attached to the inside of the cyst, and would evidently, but for the progress of the case, have been inclined to refer it to the incipient stage of cancer.*

Blood-cysts could only be distinguished from serous or hydatid cysts by puncture. In the great majority of cases they would require complete removal, by amputation if necessary. If the surgeon can satisfy himself of the absence of all soft solid matter around the cyst, he may in rare cases be justified in endeavouring to procure its obliteration by laying it open and stuffing it with lint; but it must be borne in mind that such measures can only do harm if there be anything of a malignant taint about the disease.†

Fibrous and fibro-cystic tumour.—The great majority of the innocent tumours of bone which are not osseous will be found to be cartilaginous or myeloid; but a smaller number present the fibrous character more or less perfect. Perfect fibrous tumours appear as outgrowths from the periosteum; and the most familiar examples of them are the fibrous polypus of the nose, which is treated of in the essay on DISEASES OF THE NOSE, and epulis, which will be found treated of among the DISEASES CONNECTED WITH THE TEETH. As in other situations, fibrous tumour could hardly be distinguished from enchondroma before removal, and the diagnosis, even if it could be made, would be quite unimportant. We need not, therefore, give examples of the disease occurring in other parts of the body. Scattered specimens will be found in most of our large museums, and in many of them ossification will be found to have made some progress. In some of these cases the innocent nature of the disease is proved by the history, in others it is an inference from the structure of the tumour. Calcification occurs in these as in other fibrous tumours (St. George's Hospital Museum, ser. ii. No. 152).

Fibro-cystic tumour of bone is a disease which is little known, and may therefore possibly be of very rare occurrence. It is,

* It is possible that this affection may have been, as Mr. Paget hints, a myeloid tumour, in which the cysts, which are so common in that disease, were developed out of proportion to the solid part (see vol. i. p. 536).

† In Nélaton's *Path. Chir.* vol. ii. p. 48, will be found a striking representation of a large multilocular cystic tumour developed in the femur, and containing bloody fluid. Unfortunately there is no history of this case.

however, also possible that this apparent rarity may be due to the fact that most of the examples of this disease have been confounded with malignant tumours. A very interesting account of a growth of this sort connected with the femur, in which the limb was removed at the hip-joint by Mr. J. Adams, will be found in *Path. Soc. Trans.* vol. v. p. 254, and, appended to the account of this case, a report by Mr. Prescott Hewett on three similar cases, in all of which the femur was the seat of the disease, and in all of which the patient recovered after amputation, and remained well for many years afterwards. There is therefore the strongest reason to believe that the disease was not cancerous. It commenced, in each of the four instances alluded to, in the cancellous tissue of the bone, making its way outwards, infiltrating the shaft, and causing spontaneous fracture; so far, therefore, exactly resembling cancer. It gave the sensation of an elastic substance, with fluid here and there in cavities. There seems to have been no diagnostic mark between it and cancer during life, except the negative indications to be derived from the absence of glandular or constitutional contamination during a somewhat long disease, the duration of the affection being, in the two cases in which that point was noted, three and four years respectively. On examination after removal, the innocent nature of the disease was inferred from the large quantity of firm glistening fibrous tissue of which nearly the whole solid portion of the tumour was formed, the presence only of such cellular elements as are found in growing fibrous structures, and the absence of cancer-juice, or any other indication of a tendency to disintegration in the tumour, or infiltration of neighbouring tissues.

Myeloid tumours, the only other form of innocent tumour which it is necessary to particularise, will be found sufficiently described in vol. i. p. 535.

Entozoa in bone.—A very few words must suffice for the description of the cases of entozoa in the interior of bone. The entozoon appears to have been the ordinary echinococcus in all cases except one quoted by Mr. Stanley, in which the *cysticercus telæ cellulossæ* is said to have been found in the interior of one of the phalanges. The subject is of no very great practical importance, since it is seldom possible to diagnose the nature of the affection previous to operation. The cases are so

rare, that in the great work of Rokitansky* only eight are referred to, as the total number which he supposes to have been then observed. A search, however, through the various pathological collections would probably discover many more than these.† It is noticed by Rokitansky,‡ that the disease appears often to be directly induced by some injury; but it is difficult to believe that this can be otherwise than accidental. The disease runs a protracted course, and if the shaft of a long bone be the part affected, fracture, spontaneous or accidental, is very probably the first thing noticed. The fracture, in all probability, does not unite; and it has sometimes happened that in an operation, undertaken for the purpose of resecting the ends of the fracture, the hydatid cavity has been exposed and the globular acephalocysts discharged.§ Amputation is then indicated in ordinary cases; but one is on record, in which the hydatids were scooped out of the cavity of the cyst, which then filled up and a complete cure was obtained.|| In other cases, the seat of the disease is in a flat bone, as the skull,¶ or ilium,** or in the expanded head of one or more of the long bones.†† These cases are quite within the reach of cure when their nature is discovered; and in some rare instances, as in Mr. Coulson's and Mr. Stanley's cases, the discharge of hydatids through a spontaneous opening or a puncture, enables the surgeon to determine the nature of the disease beforehand. Failing this, the symptoms are precisely those of any other cystic tumour of the bone.

The treatment appears to be usually successful. The cyst is to be freely laid open, with the trephine or bone-nippers if

* *Syd. Soc. Trans.* vol. iii. p. 184.

† The Museums of Guy's and St. Thomas's Hospitals contain at least five specimens.

‡ Loc. cit. See also the histories of the cases which have furnished the specimens to St. Thomas's Hospital Museum, marked ser. c, Nos. 230, 253.

§ Dupuytren, *Lec. orales*, 1839, vol. i. p. 52; St. Thomas's Hospital Museum, ser. c, No. 230.

|| Mr. Wickham's case, *London Medical and Physical Journal*, vol. lvii.

¶ Keate, in *Med.-Chir. Trans.* vol. x. St. Thomas's Hosp. Museum, c. 6^l.

** Stanley, op. cit. p. 190.

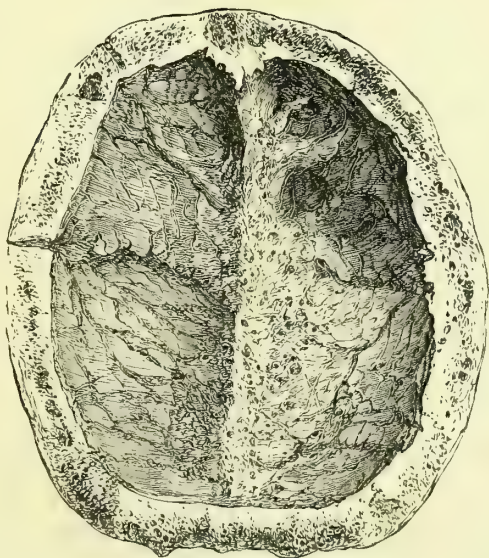
†† Coulson, in *Med.-Chir. Trans.* vol. xli. In the specimens in St. Thomas's Hospital Museum, c. 253-4, hydatids were found simultaneously in the lower end of the femur and contiguous head of the tibia. Other cases are noticed in the bodies of the vertebræ. Dupuytren, loc. cit. Guy's Hospital Museum, No. 1029³⁰.

necessary; all the hydatids removed, and some caustic* applied to the whole interior of the cyst. In most of the recorded cases this has been sufficient; but in Mr. Coulson's case the cure was not completed until after the separation of a small piece of bone from the floor of the cavity, which on examination was found thickly studded on both its surfaces with a great number of minute hydatids.

HYPERTROPHY AND ATROPHY OF BONE.

The condition of bone usually known by the name of hypertrophy is very generally the consequence of chronic osteitis, and

FIG. 205.



Hypertrophy of the cranium. (Museum of the Royal College of Surgeons. No. 2858.)

would perhaps be more conveniently designated by some name expressive of its inflammatory origin. Thus, most of the specimens of 'hypertrophied cranium' seen in our museums will be found, if the history be known, to be taken from cases of injury, or to be connected with syphilis or scrofula. The cases also of elongation and thickening of the bones of the leg, related by

* Nitrate of silver, lint impregnated with a saturated solution of sulphate of copper ('blue lint,' as it is called at St. George's Hospital), caustic potash, and the actual cautery, have been used.

Mr. Stanley * under the head of 'hypertrophy,' appear all of them to fall more naturally under consideration with the sequelæ of inflammation, which have been described above. It appears that this thickening may go on for an indefinite period after the cessation of any symptoms, and that the enlargement of bulk which follows from it is permanent. It is true that in many of the cases of thickening, whether of the skull or of the long bones, which are preserved in pathological collections, no history of injury or inflammatory affection has been obtained; but the exact resemblance of the specimens to those in which such a history does exist, leaves no doubt that most of them are specimens of chronic inflammation. Cases do, however, occur, though so rarely as to be rather matters of curiosity than of practical interest, in which a bone (the skull for the most part) has gone on increasing in size without any symptoms except those produced by its increase in bulk. Such was the well-known instance related by Mr. Prescott Hewett, in his lectures at the Royal College of Surgeons, in which a man's skull continued to increase in size from year to year, with no symptoms whatever, so that he was only aware of the fact from the increasing size of his hat. The disease, however, in this case was clearly traced to an injury. As no symptoms can be attached to such cases, no treatment is known to have any influence upon them. In the absence of any constitutional affection, the persevering use of counter-irritation, by iodine or blistering, would appear to hold out most hopes of checking the growth.

Atrophy of bone is a more frequent and a more important disease than the opposite condition of hypertrophy. Inflammation, fatty degeneration, disuse, and injury are frequent causes of atrophy; and there is also a simple atrophy, in which the composition of the bone is unaltered, and in which no obvious cause is present (unless it may be the general failure of nutrition in advanced life), and where the amount of bony tissue becomes gradually less and less, until the bone is no longer strong enough to resist slight violence.† As a consequence of senile change, or fatty degeneration, atrophy is one of the most common causes of spontaneous fracture. It may also occur in any bone, to some extent, as a consequence of confinement

* Op. cit. p. 5.

† Humphry, *On the Skeleton*, p. 8.

during a lingering disease.* Brodie says,† ‘All bones in a state of inaction lose a great part of their phosphate of lime. After compound fracture, when the patient has been long confined, the bones in some instances become as soft as a scrofulous bone, so that you may cut them with a knife.’ The cases which are spoken of under the name of ‘fragilitas ossium’ appear to belong for the most part to the class of fatty or senile atrophy. Injury sustained in fracture is also a frequent cause of atrophy. Of this, the most extraordinary instance is that quoted by Norris,‡ in which, after two fractures occurring at the same point, near the middle of the humerus, the whole bone disappeared, so as to leave the fore-arm ‘swinging hither and thither like a thong,’ and the arm shortened six inches. It is expressly stated, in the account of this curious case, that there was no open sore, and that the bone disappeared ‘by the gradual action of the absorbents.’ Mr. Curling§ believes that the cause of atrophy after fracture may often, if not always, be found in injury to the medullary artery. Even allowing, however, that this explanation is plausible in some cases, there are others (not to speak of extreme instances like the one just cited) where it cannot apply. Such are cases of atrophy of both fragments, or of the bone in the neighbourhood of the fragments, while the latter are not so much atrophied.|| Atrophy from inflammation is a condition illustrated by many morbid preparations, though it does not attract much attention in practice. It is merely the persistence of that degenerative change which leads to inflammatory softening; and probably many of the cases of atrophy after fracture should be referred to this head.

Connected with atrophy is the suspension of growth, occasionally, though rarely met with, in which the epiphyses remain separate from the shaft of the bone; and it seems probable that injury to the epiphysial cartilage, in separations

* See a preparation, No. 384, in the Museum of the Royal College of Surgeons, with its history.

† *Lect. on Pathology*, p. 409.

‡ *Amer. Journ. of Med. Sc.* Jan. 1842, p. 39.

§ *Med.-Chir. Trans.* vol. xx.

|| See a preparation in St. Thomas's Hospital Museum, series c. No. 2. Here the atrophy is most marked in the *upper* part of the shaft; and the fragments included between the fractures (which were triple) are thicker than either of the portions of the shaft.

of the epiphysis, may occasionally give rise to shortening of the bone from suspension of growth between the shaft and epiphysis.*

Atrophy of bone is an affection which does not appear to be marked by any peculiar symptoms, or to admit of any special treatment. After injury to any part, the restoration of moderate functional activity as soon as it can prudently be recommended, the avoidance of any cause of pressure on the main vessels or those of the surface, and the choice of a suitable posture, with attention to the general health and nutrition, are the objects of a judicious treatment, irrespective of the condition of any particular part; and these measures are all that could be suggested to avert atrophy of the bone, even if it were known to be impending.

Spontaneous fracture has been mentioned repeatedly in the previous pages, in connection with several morbid states, which may be thus enumerated in the order of their presumed frequency as causes of fracture: viz. senile atrophy, malignant disease, tumours of other kinds, including hydatids; the ulceration which accompanies necrosis, and, lastly, other kinds of ulceration. But besides these, cases of spontaneous fracture occur without known cause; sometimes in making a violent muscular effort, as in throwing a stone, or striking a blow; at other times in the most ordinary action, as in turning in bed, quiet walking, &c. Those which are caused by violent muscular efforts too nearly resemble the ordinary cases of fracture (particularly fractures of the patella) to call for any remark here; and the treatment of the fracture in the cases which occur during the progress of known disease is a matter usually of subordinate importance, and has been already sufficiently discussed in treating of the disease. I would merely add, that when the long bones are perforated by ulceration occurring around a sequestrum, the question of amputating the limb, or attempting to save it, will demand much care, and that, as a general rule, amputation will not be required in the upper extremity, nor should it be performed in the spontaneous fracture which rather frequently follows acute necrosis in children, unless the general health is evidently giving way; but in other cases of necrosis of the bones of the lower limb, and in almost

* *Surgical Treatment of Diseases of Infancy and Childhood*, 2nd ed. p. 238.

all cases of ulceration not due to the separation of a large sequestrum, amputation as a general rule is indicated. When fracture occurs during the ordinary muscular exertion of everyday life,* and in persons not known to labour under any disease, various remote causes have been imagined, but none have been proved to be really efficient. The one most commonly admitted is syphilis; but, not to dwell on the fact that the accident has occurred in many persons in whom the strongest reason existed for believing that no such taint was present, all that we know of the action of syphilis on the bones tends to show that (apart from ulceration and the separation of necrosed portions) it renders them not more but less brittle. The practical point of chief interest connected with such cases is, that there is no reason to despair of union, and that they should be treated in the ordinary way, with perhaps more than the ordinary care to avoid constriction of the soft parts.

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T. HOLMES.

* Some interesting cases are to be found in Robert, *Conf. de Clinique Chir.* 1861; and many are scattered about in various books and periodicals. I remember seeing at St. George's Hospital a stout, florid young man who had fractured his thigh in simply walking across his room, without catching his foot or making a false step. It healed like any other fracture.



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